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COMPUTER AS TUTOR:

THE POLICY ENVIRONMENT

IN

COMPUTER LEARNING IN CANADA

by

Teresa Plowright

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Working Paper

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EXECUTIVE SUMMARY

Computer learning (the use of the computer to teach and train) is of industrial policy interest for two main reasons. First, the extensive public sector procurement in education and training is already having major impacts on Canadian industry in this area. Often, procurement is occurring without sensitivity to industrial goals. Secondly, computer learning is a rapidly growing "high technology" industry. If Canada is a passive market for foreign products, trade deficits will become a problem; alternatively, Canadian industry can seek opportunities domestically and abroad.

Computer learning also entails a set of educational policy issues which are outside the scope of this report. However, one issue, the preference for Canadian content in education, may have industrial results that benefit Canadian firms.

Part I of this report provides a basic introduction to computer learning (CL). Chapter Two reviews a number of trends in CL development, including: an increasing professionalization, the use of "unstructured" applications (such as LOGO for children) and applications with intelligent "coaches" or guides; and a progression toward increasingly intelligent systems.

There are also a number of limiting factors currently: (1) the high cost of content development; (2) problems in the supply of microcomputer content (—poor quality, copyright infringements, and disorganized supply channels); (3) incompatibilities; and (4) shortage of expertise. Two needs that stand out at present are: the need to improve the quality of content, through improved evaluation and through increasingly intelligent CL and the need to decrease or offset the cost of content creation.

Chapter Two also describes five major computer learning systems (PLATO, TICCIT, CAN, NATAL and LOGO), each of which was the result of r&d carried out with public sector support. More recently, there has been a proliferation of entrants in the software marketplace for microcomputers.

Chapter Three reviews a number of technical components of computer learning, including the use of mainframe, mini- and microcomputers, handheld units, videodisc systems, and authoring tools. New capabilities, such as speech processing and intelligent applications using "expert systems" are expected to greatly improve CL.

Microcomputers using floppy discs have become familiar, but means of telecommunications can also deliver software in a number of ways. This chapter discusses both local area and remote networks, "downloading" software, videotex and teletext, and the capabilities of the major delivery media (telephony, broadcasting, cable-tv, satellite and fibre optics). Computer learning can take diverse forms, and technological change is occuring rapidly. Planning should be flexible and encourage advances. Also, the regulatory environment for telecommunications should encourage experimentation; regulatory uncertainty can hinder CL.

Part II describes three major market areas for computer learning:

1) education in schools, and at post-secondary levels;
2) training (in industry or carried out by government);
3) a consumer marketplace, (where packaged content is purchased on a retail basis).

More information is needed to estimate market sizes for computer learning. Few figures are available for hardware and software expenditures, and furthermore more data is needed on these market areas themselves. Training, for example, is considered to be the most opportune market but there is little information on how much training is carried out, and at what costs, by traditional means.

In the education market, there are a number of settings for computers: (1) elementary and secondary schools; (2) formal programs in post-secondary education; (3) informal education; and (4) special forms of education (distance ed, special ed, language training, and adult basic education). In only one sector has CL grown rapidly, with microcomputers in schools. This market has been dominated by three U.S. hardware manufacturers. Now, however, therge is one machine of Canadian make (the Icon), and possibly an entrant in Quebec as well. Both are the result of provincial policy initiatives.

While the number of machines purchased rises, the quality of software continues to be a major problem for educators. For a software supplier, meanwhile, problems such as incompatible hardware and copyright infringements make the school market a fragmented and difficult one.

Training is a multi-billion dollar activity in Canada, and is carried out in a number of ways: training in industry, variously supported by industry itself or with the help of federal or provincial government; government training programs (most notably, the federal Manpower Training Program); training in the public service and the military; and training by individuals on their own initiative. CBT (computer-based training) has a number of advantages that can save money for an organization. Most importantly, training time is reduced by some 30% and simulations can reduce the need to use expensive equipment for practicing.

In the consumer marketplace, individuals typically buy software applications for microcomputers though in the future handheld units may also become important. Three types of applications appear likely: (1) "educational games" for children, which have already shown rapid growth; (2) informal learning for adults, including practical instruction, general interest learning, and informal training to improve work skills; and (3) instruction in the use of microcomputers, a special case of adult learning where demand has already been shown. Particularly in the areas of informal learning and training for adults, the three markets distinguished here (education, training and the consumer marketplace) will merge.

Part III of this report focusses on policy. Chapter Seven describes the roles of a number of government players involved in computer learning either through procurement or an interest in industrial development, at both federal and provincial levels. Splits in federal/provincial jurisdiction in education and training make the areas of education and training sensitive.

Provincial ministries of education have been the most active policy makers for computer learning. All provinces have made some efforts in teacher training and cataloguing software. Ontario has a forceful program that has produced a CEM (a Canadian Educational Microcomputer), and has a software creation project as well. Quebec also has a plan to produce a local microcomputer, and Manitoba has a new project that emphasizes the CL applications industry. Most of the attention of provincial ministries has focussed on the school system; there has been little activity at post-secondary levels. A new development in the educational context is a Secretary of State program that is funding computer learning materials.

A second major area of potential use of computers is federally-supported training. Both the military and the public service could utilize CL, and in the U.S. the military has been a major "catalyst user". However, the military in Canada has not been influential in computer learning, and awarded its major contract to date to a U.S. firm. Meanwhile, CEIC (Canada Employment and Immigration Commission) supports nearly $1 billion of training yearly, but because of a split jurisdiction with the provinces CEIC is prohibited from directly evaluating or supporting CBT.

From the industrial development perspective, several provincial ministries of education have worked in conjunction with ministries of education to plan for computer learning. At the federal level, the Department of Regional and Economic Expansion (DRIE) has not shown a great deal of interest in computer learning as a high-tech industry. However, DRIE has been involved in a specific federal-provincial arrangement with Manitoba that has foccused on CL. The federal Department of Communications has had certain interests in computer learning also.

Also at the federal level, two councils fund research in universities, but computer learning has fallen into a blind spot between their respective categories. The National Research Council, another federal council, has supported the NATAL authoring language developed in its own labs.

In this context, government is pursuing many uncoordinated policies toward computer learning. This report is based on three general recommendations:

1) public sector procurement for CL should be combined with industrial goals where possible. This approach encourages Canadian content, reduces balance of payment problems, and supports Canadian industry;

2) beyond the impacts of procurement, additional industrial development tactics are called for;

3) the federal/provincial split jurisdiction in education and training has negative impacts in this area, and ways should be found for the federal government to pursue an interest in computer learning without overstepping provincial roles.

More specifically, four needs stand out in the present policy context from the industrial viewpoint:

1) increased coordination among provinces concerning microcomputers in schools, and increased awareness among provinces of the costs of fragmented development;

2) increased profile at post-secondary levels, including research grants;

3) evaluation of computer-based training by the major federal departments involved in training, possibly followed by "catalyst use";

4) increased federal attention to computer learning, from two perspectives: an interest in educational projects and an interest in CL as an opportune industry.

Chapter Eight discusses various policy mechanisms to promote CL, which can be broadly grouped intwo three approaches:

1) Organize the Marketplace
   - build up knowledge, primarily through teacher training
   - organize content supply
   - standardize hardware

2) Provide Financial Support
   - catalyst use of CL
   - r&d funding
   - exemplary projects
   - subsidies to suppliers and to user markets
   - production resource centres (a form of subsidy to authors)

3) Create Favourable Conditions for CL Suppliers
   - provide supportive financing and tax conditions
   - encourage the software industry
   - encourage r&d supported by industry itself
   - encourage expansion into export markets

Chapter Eight also emphasizes the importance of software development and export marketing.

In the past, provincial ministries of education have often been reacting to teacher pressure to organize aspects of the use of microcomputers in schools. Their efforts have concentrated on teacher training and on solving problems in marketplace conditions where immediate problems were felt, through solutions such as clearinghouses for software.

A more forceful position is required. From both the educator and the industrial viewpoint, it makes little sense to organize the marketplace for the distribution of poor quality material, or for imported products. Financial support is needed, for content development and exemplary projects. To date, only Ontario has supported content development in a major way (though Quebec has plans to also fund software).

Financial support is also recommended in several other ways: through catalyst use of CL, particularly by CEIC, with its roles in manpower training; research grants to universities; exemplary projects funded by both provincial and federal governments; and production resource centers that indirectly subsidize authors.

Industrial development programs which give grants to CL firms will quickly evoke responses from industry. Industrial development policies, however, should focus on creating a favourable framework for suppliers generally, rather than only select a few firms to benefit from a granting program. R&d should be encouraged within industry by tax policy; the software industry should receive favourable treatment; and financing assistance should be made available. Finally, export market support is critical. A variety of means can be used to encourage expansion into export markets--financing aid, trade agreements, market intelligence, and so on. A particular mechanism to promote trade with South East Asia is recommended in Chapter Nine.

A specific recommendation is also made for an increased federal interest in computer learning. The federal government is already funding CL in at least six different agencies. Lack of coordination is likely, and it is difficult for any one agency to assess its own interventions in such a context. Also, the federal government can fund exemplary projects and r&d (in firms or at universities) that are unlikely to be supported otherwise. A federal advocate for computer learning is also needed to make recommendations to other federal departments on copyright law, tax law, and telecommunications regulation that affect CL. It is recommended here that the federal government have two focal points of interest in computer learning: from the industrial development perspective, and from an interest in educational technology. Joint planning between these two bodies should occur.

It is also recommended that other provinces reconsider the costs and benefits of using Ontario's hardware and participating in Ontario's software creation projects. In particular, provinces should (at the least) facilitate participation in these projects by their local software authors. At present, the provincial approaches to computer learning reflect certain Canadian realities: Ontario has a forceful program that is stimulating industrial activity; Quebec is proceeding on a course of its own; and the other provinces hold weaker positions. Ontario is large enough to create a viable English-speaking marketplace, and if its projects are successful other provinces may face criticism for using U.S.-made material while schools in Ontario have Canadian content. Also, other provinces will not have benefited from the industrial activity stimulated around the CEM.

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CHAPTER ONE THE POLICY INTEREST IN COMPUTER LEARNING

Leaving behind its identity as a number cruncher, the computer is appearing in a number of new forms. Robots are infiltrating assembly lines, workstations are winking on office desks; and after years of slow progress, computers are proliferating as learning tools. Computers are being used as teachers' aids in schools, and they are automating training courses in industry. In more advanced forms, they can simulate equipment and experiments, using expert knowledge that guides the learner like an intelligent "coach".

This study examines industrial policy issues for a major new application of computer technology: the use of the computer to teach and train. The term computer learning (CL) is used here to refer generally to the use of the computer as a learning tool. Three main markets for CL are emerging:

1. in educational institutions (both at school and post-secondary levels);
2. in training (carried out by industry, government, or the military);
3. in a consumer marketplace (using microcomputers with retailed software, or handheld technology).

All three areas are experiencing rapid growth.

There are two main reasons for policy interest in this area. Most basically, the extensive public sector procurement in education and training is already having major impacts on the industrial development of computer learning. Often, however, procurement is occurring without sensitivity to industrial goals.

Secondly, computer learning is an opportune and important "high technology" area. As part of a wave of advances in microelectronics, CL has reached the point of commercial success. Several industrial concerns arise in this context: will Canada become largely a passive market for foreign products? Or can Canadian industry capture market opportunities, both domestically and internationally?

A third policy interest in computer learning relates to the educational system. Provincial governments have pursued different approaches towards microcomputers in education; some provinces have actively promoted computer learning while others have taken almost no action. There may be a gap in the quality of student access to computer learning in different provinces; there may also be "computer rich" and "computer poor" schools. The use of Canadian vs. imported content is another important question in education. These issues are outside the frame of reference of this study, but are briefly discussed in this introductory chapter.

1. Public Sector Procurement in Education and Training

In the past five years, the use of microcomputers in schools has multiplied. Provincial ministries of education have been called upon to make certain decisions about hardware and software supply that thrust them into the roles of de facto industrial policy-makers. Some provinces, such as B.C., have chosen to take minimal steps in this area; still, their actions, or lack of actions, have directly influenced the type of machines and the content in use. Other provinces, (most notably Ontario), have moved ahead with forceful programs that deliberately combine educational development with industrial goals.

In hardware, Ontario has nurtured a Canadian Educational Microcomputer (--a CEM), and Quebec is also supporting an indigenous machine. Ontario has also taken pains to promote quality applications and Canadian content--two important concerns from the procurement or user viewpoint. For cultural reasons, Canadian content in education has been encouraged with textbooks, and a similar desire arises with computer software.(2) The decision to encourage Canadian material immediately benefits Canadian firms; however, many provinces have relied on a major U.S. educational consortium for software.

The federal government is also involved in the user or procurement side of computer learning, through training. The Canada Employment and Immigration Commission (CEIC) supports nearly $1B a year of manpower training and training in industry. In recent years, a number of initiatives using computers have been federally supported; however, because of split jurisdiction with the provinces in this area, no systematic evaluation, or support, of computer-based training can be undertaken by the federal government. The military also carries out extensive training; here, however, the major computer-based training contract to date was awarded to a U.S. firm.

This report takes the position that procurement for computer learning in the public sector should support industrial goals where possible. There is virtually no way that government can remain aloof to industrial policy in this area, given its role in education and training--even the failure to take a position has a significant impact on the conditions for Canadian industry. Government actions towards CL can remain ad hoc and unorganized; but can't be without influence.

2. Industrial Development Interest

As the markets for computer learning develop, they will represent sizeable expenditures for both hardware and software. Canada could become largely a passive market, buying Asian or U.S. hardware. Canada could also purchase readymade U.S. content--(a prospect counter to decades of promotion of Canadian content in other media).

Rather than follow the passive-market model, Canadian companies could capture some share of both domestic and international markets for CL. The potential for computer learning world-wide is highly attractive. There is no established market dominance in this area: no giants reign, in either hardware, software, or content applications. Also, no country has advanced to the point where quality material is plentiful.

Computer learning is one of a number of "high tech" industries where trade deficits have become a serious problem. Canada is an exporter of resources, and an importer or information technology. In 1980, for example, software exports were $35M (only 7.6% of total software revenues of $457M); imports were over $900M,(3) creating a software trade deficit of almost $1 billion. The 1980 trade deficit in computer and office equipment was $1.2B; this figure had risen to over $2B by 1982.(4) There are no figures available that deal with computer learning separately; however, in the elementary/secondary school system alone, it is likely that over $66M has been spent on U. S. hardware so far.(5) Software expenditures in schools are roughly expected to equal the sums spent on textbooks, within a few years; over $132M was spent on school textbooks in 1979.(6)

One way to promote the industrial development of computer learning is through the existing procurement needs of the public sector. Procurement in this case is not an invented need (as it sometimes is when the development of a technology precedes demand). Rather, the aim is to make existing purchases of computer learning sensitive to industrial goals.

Other means that can be used to promote the computer learning industry include: (1) exemplary projects; (2) production resource centres; (3) research projects at post-secondary institutes; (4) support or encouragement for r&d in industry; (5) encouragement of export marketing and (6) favourable tax laws. Industrial development strategies in this area should consider:

1. the importance of artificial intelligence approaches in computer learning, which are expected to mean a breakthrough in quality. The encouragement of AI will improve the quality of content available in Canada and will equip Canadian suppliers with more impressive products for international sale.
2. the importance of the software industry. The development of applications software should be emphasized.
3. The need for export marketing, given Canada's small market size. Export marketing in particular should move beyond the dominant trading patterns of the past.

3. The Policy Context for Computer Learning

A large number of government players are making decisions that affect CL development currently. Ten different provincial approaches are being pursued towards computers in education, with relatively few channels for cooperation to take place. On the federal level, the Canada Employment and Immigration Commission plays an extensive role in training, as noted earlier, but has no jurisdiction to evaluate computer-based training as a training tool.

There are other pockets of federal interest in computer learning. The National Research Centre (NRC) has developed the NATAL authoring language; other federal councils give research grants to colleges and universities, and could fund projects in CL. Within the federal Department of Communications, there has been intermittent interest in computer learning as well, and Secretary of State has recently begun a program to fund educational software. The NRC also has an Associate Committee on Instructional Technology which has been considering an industrial strategy for CL.

Meanwhile, the Department of Regional and Industrial Expansion (DRIE) has received requests from firms for industrial grants, but has no formal position towards computer learning as a special area of high technology. Several provincial ministries of industry have also been involved with computer learning.

This is a complex policy environment: disparate parties are involved, from the user or procurement perspective; from the industrial development perspective; and also from both federal and provincial levels of government. The split jurisdiction between federal and provincial governments in education and training makes any federal actions towards computer learning delicate.

There is a need for coordinative mechanisms so that the decisions taken by different government parties will not work at cross purposes. This is especially critical, given a technical characteristic of computer learning: incompatibility. Content cannot generally be moved from one type of computer to another or from one programming language to another one. When decisions are made to use a particular machine or language, they can fragment the marketplace.

Canada had an early start in computer learning and began developing two major systems over ten years ago. By the 80's, however, when CL began to be commercially successful, the status of the Canadian industry was weak. Major advances have been made in the past two years, largely due to the efforts of Ontario. At the same time, however, computer learning has been adversely affected beyond the provincial level: through a lack of coordination among the provinces, (especially in the critical years when Ontario was only beginning its initiatives); and through minimal federal attention. There are certain types of major projects, in either education or training, that only the federal government is more likely to support than its provincial counterparts; the federal government could also act as a "catalyst" user in exploring computer learning, (as has occured in the U.S.) Federal interest has been confined to the National Research Centre, which has concentrated on the development of a particular authoring language, NATAL.

Computer learning could benefit from a higher profile in federal circles, to combine procurement with industrial goals and to foster CL in "high tech" development policies, as a growth area with export opportunities. The low interest in industrial development for computer learning has probably resulted from two main factors: federal/provincial sensitivity; and the lack of statistics for potential markets (which continues to be a problem).

This report is structured in three parts. Part I explains the basics of computer learning, with special attention to factors that limit development. Part II describes three major settings for CL: the public education system; training carried out by industry, the military, or government; and the consumer marketplace. These areas are described as three broad "markets", though figures for the size of these potential markets are, unfortunately, seldom available. Part III discusses the policy context for computer learning.

The remainder of this chapter discusses a number of issues from the educational perspective.

4. Questions for Educators

While this report is written from the industrial viewpoint, computer learning also raises questions for educators. These issues lie outside the frame of reference of this study, but because they are signficant questions they have a place in any introduction to computer learning. Several issues are briefly mentioned here which concern pedagogy: the art of teaching, and how the computer performs as a learning tool. This section also discusses the larger phenomenum of the computer in society.

Two major points that arise from the educational viewpoint are important to industrial development:

1. the question of the quality of CL material. (Quality has often been

poor in the past, and in general the potential of the computer has scarcely been explored); and

2. the preference for Canadian content in the educational system.

A third educational policy issue is that of access to and specific uses of computers in schools. There is already a trend for computers to widen the gap between rich and poor students: wealthier children are more likely to have microcomputers at home and to live in school districts where more microcomputers are bought. Exposure to computers is widely held to be important to a student's education, and to affect career opportunities; any major variations in the quality of access will eventually become a policy concern.

i. Advantages and Disadvantages of CL

The most proven advantage of computer learning is cost-effectiveness in the training environment. CBT (computer-based training) typically reduces instruction time by 30%, and sometimes more. Trainees are usually being paid while learning, and any reduction in time results in immediate savings. As Chapter Five discusses, CBT can frequently be cost-justified within large organizations.

A second major feature is the computer's ability to "individualize" instruction. Through conditional branching in its programs, and with increasing intelligence, the computer can provide a learning session that is responsive to individuals in different ways. Also, "self-pacing" allows the learner to proceed as quickly or as slowly as he or she wants.

A third advantage the computer offers is simulation: the ability to simulate real-life equipment and conditions so that the learner can practice freely and inexpensively. Simulations are particularly effective in training settings, where expensive machines can be simulated for practice at greatly reduced cost.

In the training context, the pedagogical goal is a relatively straightforward transfer of information. As long as the computer imparts instruction adequately, cost-effectiveness is the major concern. In addition to simulation and faster training time, the computer can save money through an increase in the student:teacher ratio and by removing the need for trainees to travel and stay at instruction centres. In the educational world there are a different set of conditions, and cost-effectiveness has not been an important issue.

It is an intriguing point that the computer has not been embraced in schools because it reduce costs, or because it is a better way to teach. In fact, evaluations of the computer as a teaching instrument have been done in very few instances. Where evaluation has occurred, the computer has appeared to be "at least as good" as traditional methods in conveying knowledge (7) --a justification, perhaps, for its use, but hardly a compelling reason. Something else is driving the use of the computer along.

What is causing schools to buy microcomputers--at a time when the lack of quality software is a major complaint? One major feature of the computer is the interest it holds for students. In a recent national survey in the U.S., teachers felt the motivating aspect of the microcomputer was the most important factor at this point.(8)

Children react enthusiastically to computers and may tend to see them as an extension of video games. Attention is held intensely with computer interaction, and studies have indicated that the time spent on a task is increased with computers--a factor that relates directly to achievement levels.(9) Thus a main driving force in the use of microcomputers is attitudinal: children are interested in computers. It seems likely that teachers are interested in using them too.

In addition to this general appeal, computers have proved especially suitable for students with learning difficulties. The computer has been successfully used with dyslexic students, students with behavioural problems, and handicapped learners.(10) The computer is patient, and picks no favourites or scapegoats. It seems to benefit those who don't do well in the typical competitive setting of the classroom and has been used beneficially, for example, with "delinquent" students.(11) Unfortunately, for economic reasons, often these "underachievers" are less likely to have computers at home.

This last point relates to the larger context for CL outside of the classroom: computers are multiplying in society generally and it is increasingly considered essential to expose students to computers. "Computer literacy", if only to familiarize students with the basic elements of a computer, has been a major force motivating the purchase of microcomputers by schools. The larger phenomenum of the growth of computers is discussed below.

The main negative aspects to the use of computer learning have arisen in the educational world. An early concern was the impact of computers on jobs for teachers; it was feared that automated courses would replace teachers in the class. Instead, the pattern with microcomputers has been to use the computer for short periods to complement what the teacher does (--for "lessonware" rather than "courseware", or for sessions with non-structured applications such as LOGO geometry).

Another major concern about computers was that learning would become too impersonal--that the human touch would be lost. The question of what functions of education the computer can carry out is discussed briefly in the following section.

Perhaps the most important criticism of computer learning (and the one about which educators have been most vocal), has been the poor quality of the material that is currently available. A related problem is that evaluation of material has not received adequate attention. Also most evaluation is done after the fact, and done with little input from students even though they are the ones who will use the material. The area of formative evaluation, (evaluation which feeds into the design process), has been neglected, and new techniques to evaluate CL must be devised.

ii. Philosophies of Education

A basic question about computers in education is: what roles can the computer play? Certainly, it can transfer information, as a book might, and perform such tasks as administering tests; but how much further can it go, in doing what a human teacher does? The answer seems to be that it can do much more than it is doing presently; and that it is important to acknowledge a unique human component in education as well.

Chapter Two describes sophisticated approaches to computer learning that are based on artificial intelligence (AI). These approaches turn the computer into a responsive "coach" in a particular domain of knowledge. The ideal model of interaction is a one-on-one dialogue between the student and a knowledgable expert and the term "socratic dialogue" is sometimes used. The potential of the computer as an intelligent tutor goes far beyond the applications typically available now.

Most applications currently are based on simple behavioural models of student interaction with the machine: questions and answers, response reinforcement, and so on. There are a number of technological and other biases in favour of simple applications. They are cheaper to make; they are also easier to make, so that many more people can "author" this sort of material. Authoring systems have been devised with "templates" for lessons or tutorials that are easy to use but embody very simple forms of CL. Also, microcomputers have not had the capacity to carry out AI-based programming (--though this is changing rapidly). Standardization on a particular type of hardware or authoring approach can (even inadvertently) limit advances. It is a basic point of this study that more intelligent CL should be actively sought.

The computer can move far beyond the simple transfer of information to the learner. The transfer of information, or the "didactic" element, is the most straightforward aspect of the learning process and is also the aspect of teaching that is most easy for the computer to replace. A second element in education can be termed "heuristics":(12) that aspect of teaching that emphasises discovery and creativity, inquiry and demonstration, rather than simply passing information on. The teacher is more of a "coach" and learning is a joint student-teacher process, as in a seminar.

This is the type of teaching that intelligent computer learning aims to provide: to offer a coach for the student and an environment (complete with simulations), that the learner can explore with the help of this guide.

There is, however, a third element to teaching that has been termed "philatics", and that deals with the emotional side of the teaching process. A teacher is also an advisor, a counsellor, a role model, and a personality that shapes lives.

Optomists about computers say that in the future teachers will concentrate their efforts on more human interaction with their students. Freed from many repetitive tasks that simply transfer information, teaching will become a more personalized, human institution; teachers will focus on giving real help and guidance. Certainly the human touch can't be replaced by a machine, no matter how smart its software is; but the way in which computers will impact the role of teachers is far from clear. (It should also be remembered that schools haven't worked for everyone.

A visionary in the computer learning world, Seymour Papert, has criticized both the education system and the attempts of most CL today to replicate old approaches to instruction. His vision is of a new computer culture where the nature of learning is transformed.(13) A tenet of Papert's philosophy is that the computer should be a tool under the child's control. Most "computer aided instruction", he says, "means making the computer teach the child; instead, the child should have a sense of mastery over the computer". Papert has little use for the trappings of the education system, such as curriculum, grades and tests.

The education system in which computers are spreading is a complex institution; it is also a cultural fixture, built by the state during the industrial age. Besides teaching subject matter, for example, schools incorporated attitudes about time (organizing subjects into 50-minute segments), and about individuality that acted as preparations for the world of work. (Schools were not designed for individual learning; imagine a factory in which everyone wanted to think creatively, or go at his or her own pace). Intelligent computer learning embodies an entirely different tradition of one-on-one inquiry-driven tutoring. Eventually, as the computer proliferates within its walls and as a powerful learning tool outside of it, the education system will change. One can only wonder in what form the emotional, "philatic" element of teaching will be present as computers evolve.

iii. The Larger Phenomenum

A major reason for the surge of microcomputers in schools is the perception, shared by parents, teachers, and administrators, that it is essential for students to become familiar with computers today. For example, a Task Force on Computers in Schools in Alberta commented that:

> ...students in the province's schools, indeed students everywhere, must have an opportunity to learn about high technology and, particularly, computers.
>
> ...Students will need computer knowledge and skills to understand and manage the changes they will face. School graduates must be prepared to

> participate in a competitive work world pervaded by computers. Prevailing trends indicate that a technological capacity is fundamental to the long-term prospects of an economically diverse province. Future job opportunities and career challenges depend upon the acquisition of this capacity. Of course this holds true for the country as a whole.(14)

The student's exposure to computers in schools is linked to personal career success, and to the country's economic success as well. Suddenly, it seems imperative to introduce students of all ages to computers. Apple Computer gave thousands of microcomputers to California schools with forceful rhetoric:

> To maintain America's technological leadership, we must begin training students--of <u>all</u> grade levels--in today's computer technology. If we do not, we risk producing a generation of Americans who will be both non-competitive and non-literate in the information society now evolving.(15)

If exposure to computers is this important, then concerns about access follow automatically. Computers tend to be found in affluent areas,(16) where it is also more likely that children will have access to microcomputers at home. Computers could widen the gap between rich and poor schools, and rich and poor homes; as one observer put it, "If computers are the wave of the future, a lot of [the country] is being washed out."(17)

To deal with this access issue, for example, Ontario is giving special subsidies to schools in less affluent areas to buy microcomputers. However, the fact that a school has a microcomputer and that the student has access to it says little about what's being done with the technology. Already, criticism is springing up; as one educator says, "We are definitely going somewhere with computers. The question remains: where?"(18)

One major problem is teacher training: "You can buy the hardware and the newest software, but if the teachers do not know what is going on, then both are useless."(19) Often, even basic teacher training in the use of microcomputers is lacking. Another issue is the quality of educational software. Drill and practice sessions for spelling and math may not only be unimaginative uses of the computer, they may encourage memory work over reasoning. Poor quality and lack of evaluation are central problems, as noted earlier.

As different provinces pursue different educational strategies, it is possible that some provinces will offer better access to computers than others --using the word "access" to include not only physical availability but the quality of software and teacher input as well. To date, Ontario's approach to computer learning appears most developed. Ontario's software project has emphasized the creation of high-quality Canadian material; but because of technical incompatibilities, this content will not run on Apples or the other machines commonly in place. Perhaps the most important implication of the fact that ten different approachs are being taken across Canada is that children will get widely varying exposure to computers and software depending on where they live.

To return to the industrial perspective that is the basis of this study, a great deal of content authoring has been stimulated in Ontario. The Ministry of Education issued a call for proposals for software projects that was open to parties across Canada. However, unless other provincial governments play a facilitory role, it is unlikely that (apart from established software firms, publishers, or long-time CL experts) out-of-province participation will be high.

Provinces which are now "saving money" by minimal action in the area of computer learning should take such implications into account in their cost-benefit equations. Without a more farsighted role, a gap between "computer-rich" and "computer-poor" provinces could appear.

CHAPTER ONE FOOTNOTES

1. Other terms often used are Computer-Assisted Learning or Computer-Aided Learning (CAL), or Computer-Assisted Instruction (CAI). Computer-based training (CBT) is a type of computer learning; this term will appear in the report as well.

2. The Canadian Teachers' Federation, for example, has frequently expressed the desire for Canadian content in computer learning software.

3. Wills, R.M., Booth P.J., and Globerman, S., (1984). $540M was for software "bundled" with hardware, and $330M was for applications software.

4. Ibid.

5. Some 33,000 microcomputers have been bought by schools (Evans Research Corporation estimates). An average cost of $2000 is assumed.

6. Statistics Canada 87-601, Cultural Statistics (1979). (Book markets).

7. The computer typically has proved to either improve learning or to show no difference when compared to the traditional classroom approach. Chambers, J., and Sprecher, J., (1980).

8. Educational Computing, Oct. 1983. Also, over 74% of the teachers agreed they were happy to see microcomputers enter the classroom.

9. Educational Computing, July-August 1983, p. 25.

10. See, for example: Ontario Teachers' Federation (1981); Brebner, Ann, and Hallworth, H. (1981); and Goldenberg, E.P., Special Technology for Special Children (Baltimore, Md.: University Park Press, 1980) for special education examples. Educational Technology, Jan. 1984, describes with a dyslexic learner; Educational Computing July-Aug 1983, p.43 discusses use with students with behavioural problems.

11. Jamison, R.N., and Lovatt, K.F., (1983).

12. Popp, Jerome, Educational Computing, July-August 1983, p. 29, using the ideas of Harry Broudy on three dimensions of teaching.

13. Seymour Papert, BYTE magazine, June 1980.

14. Alberta Printout, Dec. 1983, p. 29.

15. The Computing Teacher, August 1983, p. 8, quoting Steven P. Jobs, chairman of Apple Computer.

16. A U.S. survey found that 80% of the country's largest and most affluent public high schools had computers in 1982, whie 60% of the 2000 poorest schools had none. Time, Nov. 15 1982. (Market Data Retrieval Inc. survey).

17. Ibid. Quote from Andre Molnar, computer education specialist at

the National Science Foundation.

18. _MacLeans_, August 13 1984, p. 49. Quotation from Des Dixon, director of curriculum with the Ontario Teachers' Federation.

19. Ibid. Jim Thiessen, director of the Alberta department of education's computer technology project.

PART I

TECHNOLOGY AND INDUSTRY

PART I TECHNOLOGY AND INDUSTRY

The ways in which computers are used for learning can vary widely. CL can occur on a mainframe computer that handles hundreds of users, on a minicomputer or microcomputer, a handheld unit, or a videodisc player. Telecommunications networks can link machines in a classroom or connect "electronic universities" across a continent.

In schools, microcomputers can teach specific material through "lessonware" or "courseware", play educational games, or provide learning environments such as LOGO geometry. (Microcomputers are also used for "computer literacy" purposes, that range from informal familiarization with computers to teaching programming skills). Typically, packaged software programs are used in schools while in training settings custom software has often been created to meet an organization's specific needs. Simulations are particularly important in training, as they allow students to practice without using expensive equipment. In the home marketplace, as microcomputers increase, informal learning, educational games and unstructured applications such as LOGO will become more common.

In all these forms, the computer can become more interesting and powerful as it acts with increasing intelligence.

This section introduces computer learning: what it is, and how it is carried out. Chapter Two describes the evolution of CL from simple automated routines to intelligent systems. It focusses on one of the major elements in

CL, the authoring of applications, and also discusses several key limitations for development. Finally, it describes the five major specialized CL systems to date.

Chapter Three has a more technical orientation and describes four components of computer learning:

1. hardware;
2. authoring software;
3. applications software (with special attention to artificial intelligence approaches); and
4. networking technologies.

These two chapters provide a brief overview of the history and state-of-the-art of computer learning and the critical factors in its development.

CHAPTER TWO THE EVOLUTION OF COMPUTER LEARNING

1. From "Drill and Practice" to Smart Systems

Computer learning applications range from simple question-and-answer routines to intelligent tutors. This section introduces a number of the basic terms of reference in this area.

Computer learning has had a short history: its development began little more than 20 years ago. The early computer industry experimented with training their own personnel (using teletypewriters linked to mainframe computers), and by 1960 IBM had made the first authoring language. Soon after, pioneer work started in the academic world.(1)

As early as 1963, researchers at Stanford University were testing computerized drill-and-practice routines for math. Drill-and-practice was the earliest and simpest form of CL. The computer essentially automated the sort of exerices one might find in a textbook, adding an element of interactivity to the question-and answer format.

In the following years, research in computer learning centred on the development of a small number of major specialized systems (described later in this chapter). At the same time, a simplified programming language (BASIC) was developed for general computing use. Countless teachers learned BASIC and wrote short programs on their own, to supplement their classroom instruction.

The most common form of CL has been "tutorials" that present instructional material accompanied by interactive questions and answers. Applications have often been quite simple, and CL enthusiasts have criticized the tutorial approach as unimaginative--doing little more than transferring pages of text to the screen. More sophisticated variations of computer learning use the resources of the computer in more powerful ways, but also require more effort and expertise to make.

Simulations are computer programs that replicate a set of real-life conditions, which can then change dynamically as the learner interacts with them. For example, the learner can practice in simulated flight conditions, or conduct scientific experiments in simulated labs.

There is also a trend to enhance applications with animation. For instance, the kind of math problems commonly found in school text-books have been "animated" using cartoon-like pictures (or "icons"). The learner is able to try out different solutions, and watch the results. (In one example, a student manipulates variables of time and speed by sending two trains racing on a collision course across the screen).(2)

An important concept in computer learning is individualization: the learning process varies according to what the individual learner does. Simple applications (such as drill-and-practice) tend to present material almost mechanically, working their way through fixed sequences of content. Instead of this approach, CL can offer conditional branching: a number of alternative sequences are included in the computer program, and different sequences are evoked depending on the individual's responses. More advanced systems build up a "learner profile" of the student or trainee, that can take complex individual learning patterns into account.

More sophisticated systems are being developed that incorporate artificial intelligence (AI) approaches to CL. Two concepts are involved in these systems. The first is that of the "expert system", in which the computer is programmed with a substantial amount of knowledge in a particular domain. (For example, the SOPHIE system tutors in electronic troubleshooting; SCHOLAR is an expert on world geography; and GUIDON is a tutor built onto an existing expert system for medical consultation, MYCIN). The term "knowledge-based" is frequently used for intelligent CL.

Secondly, intelligent systems can make the computer's responses more individualized. A smart system can expand the "learner profile" idea into a mroe complex "student model" representing the hypothesized knowledge state of the learner. Based on this student model, the computer selects the best procedures to present material. (The BUGGY system, for example, can diagnose student problems--"bugs"--in doing simple arithmetic).

Another feature of intelligent CL is "mixed initiative dialogue": either the learner or the computer can initiate questions. The ability for the learner to address the computer in "natural language" (as opposed to special programming commands) is also an element of intelligent systems. Ideally the learner can interact with the computer as if he or she were having a dialogue with an expert tutor.

In sum, four trends in CL applications stand out at present:

1. Individualization is becoming more sophisticated;

2. Visual environments are becoming more interesting, with more graphics and animation, and also with tv-like segments using videotapes and discs;
3. Applications are becoming more involving for the learner, using simulation, animation, and sophisticated dialogues;
4. The use of intelligent systems is advancing steadily.

2. Unstructured Learning

As Chapter One discussed, there are major philosophical and pedagogical questions about how the computer is best put to use as a teaching tool. These pedagogical debates lie outside of the framework of this report; however, it is important to make certain distinctions about the various forms CL may take.

The computer has largely been used in educational and training settings in a didactic or directed manner, to convey a specific curriculum of knowledge and skills. Typically, material has been arranged as a sequence of instruction, and the learner works through an ordered curriculum. Various enhancements may be used (branching sequences, aminations, video narratives, etc.), but the process remains a pre-defined and ordered one.

A contrasting approach uses the computer in a non-directed way for "learning without teaching" or what can be termed unstructured learning. In this model, learning is conceptual in nature and occurs without curriculum. A young child learns much without being taught; similarly, the computer can act as a learning environment in which concepts and skills can be tried out. The LOGO system, with its world of "turtle geometry" (described later in this chapter) exemplifies this approach. "Educational games" also aspire to teach general concepts and skills in an unstructured way.

A third broad type of CL can be called coached learning. Using knowledge-based systems (that have a specific area of expertise, plus enough intelligence to monitor the learner's progress), the individual may explore a domain of knowledge with the aid of an intelligent coach or guide. Learning is "directed" in the sense that the coach makes sure that certain material is mastered. But rather than follow a sequence of instruction, learning is less structured, and the application is "inquiry driven" (i.e., the user's actions are the initiating force).

In certain settings where following a set curriculum is important, directed, ordered learning will predominate. The coached learning model, however, will become more common generally, as intelligent systems evolve. Also, as markets for educational games expand, unstructured learning can be expected to increase. Similarly, adults interested in informal learning may have little use for a set curriculum; the goal may be as practical a task as gardening, and unstructured access to an intelligent expert may be the best approach. Computer learning is not only a means to put courses or lessons into the computer; "learning" is a broad term, and informal learning may occupy a major part of the marketplace.

3. The Authoring of CL

Several trends in authoring are described here, including an increasing use of authoring teams, and shifts towards more professional and commerially oriented products.

Creating applications is a time-consuming process: often 200 to 300 hours of development are needed to create one hour of material. As Chapter

Three discusses, a number of authoring tools have been devised to speed up content production. Certain tools today can allow simple applications to be created easily; however, more sophisticated, imaginative applications still demand more complicated programming. Authoring also requires a combination of programming expertise plus educational skills such as instructional design. The poor quality of much CL material in the past reflects both limited programming skills when educators have authored material and poor educational design when programmers have attempted authoring.

i. From Teachers to Expert Teams

For much of its short history, apart from work at a small number of specialized centres computer learning was largely an amateur activity among a subset of teachers in educational institutions. The typical pattern was for a motivated teacher to learn the BASIC computer language, and write short programs for his or her own classes. Content creation in these educational settings was a labour of love.

There were several advantages to this approach: the cost of writing programs was hidden, and material could be freely exchanged among teachers with no concern for financial gain. Also, the material used reflected the individual teacher's unique viewpoints, and was locally relevant (--so that, for example, students in B.C. didn't find all their examples set in Toronto or the U.S.) The weaknesses, however, included poor quality, a lack of evaluation, poor documentation, and a tendancy to make only very simple material that didn't tap the computer's capacities.

In more recent years, few of the thousands of teachers interested in microcomputers want to author their own material; instead they use pre-made software typically created either by commercial suppliers, or by special educational computing organizations such as MECC (Minnesota Educational Computing Consortium). Authoring has become a more professional, specialized activity--with an accompanying emphasis on commercialization, discussed below.

One of the features of this shift in authoring has been an emphasis on teams that bring together different expertise: content experts, instructional designers, graphic artists and programmers.

Even authoring teams that combine skills, however, have been the target of criticism about quality. One problem, it has been suggested, is that in the team approach no individual feels responsibility for the final product.(3) Some teachers have begun to look for the work of specific authors, to have more trust in the quality of the software they buy.

In the training context, authoring did not have the hobbyist history found in the educational world. However, CBT (Computer-Based Training) shares the trend toward authoring teams, and towards increasing commercialization, discussed below.

Another element in CL authoring is the use of production centres. A centre can gather together a permanent core of experts, and provide a place for others to apprentice in computer learning skills. It can also assemble computer resources, such as authoring software and sophisticated authoring equipment for graphics, voice and video.

ii. A More Commercial Outlook

Along with increaseed professionalization in authoring, a commercial viewpoint has become more prominent. The costs of writing content are no longer hidden as they were when teachers programmed material without reimbursement; content is likely to be a copyrighted product made by an organization that wants financial gain when it is used.

Increasingly, CL authors are thinking as commercial publishers would, in terms of professional products with resale potential. In training, the resale of content that a firm has created for its own internal use is a way to offset the high cost of authoring. In education, an emphasis on merchandising is part of a more professional outlook towards content generally. MECC, for example, has actively promoted its content outside the state, and several Canadian provinces have arranged for MECC material to be used in schools. MECC also markets individual software packages. In Ontario's project to fund software creation, the software supplier retains the rights to market its product outside the province and within Ontario apart from school board use.

In the new, more commercially attractive context for computer learning, three main approaches are being taken towards content. Software firms may decide to make products for the open marketplace, encouraged by the large number of microcomputers now in place. Secondly, those who are making CL for their own use (either in education, or in training settings where organizations create content for their own needs) are thinking increasingly in terms of resale and licensing agreements for the use of their material. Thirdly, many commercial CL firms create content on a client basis--for example, contracting to develop courseware for a large firm.

4. Central Problems in CL Development

There are a number of characteristics of computer learning that have been critical in its development in the past, and that continue to limit its growth. This section discusses:

i. the cost of content development

ii. problems in the supply of microcomputer content (poor quality, copyright infringements, and disorganized content supply)

iii. incompatibilities

iv. shortage of expertise

While the problems discussed here are general, the ways in which difficulties are experienced will vary with different contexts. In education, the emphasis is on a number of problems in the supply of microcomputer software. In the computer-based training world, where custom-made content has been dominant, a major holdback lies with the high costs of content creation.

Another critical issue in CL development is the sophistication of applications software. The quality of CL content has been a major complaint, especially in the context of microcomputers in education. Intelligent computer learning applications can be vastly more responsive to the learner; however, the use of artificial intelligence is limited at present by a number of technical constraints discussed in Chapter Three. Intelligent systems will be a breakthrough in computer learning; and though the meagre use of AI today is not a visible problem as are the other subjects listed here, AI is perhaps the most critical factor in CL development overall.

It is in the context of these limiting factors that policy initiatives for CL are formulated. Many of the policy moves taken to date (by provincial ministries, for example), have been a reaction to the problems described here, and any future initiatives must consider these basic factors as well.

i. Cost of Content Creation

Despite the falling price of computer power, costs of developing CL content remain substantial. These costs include equipment, software tools, and an extensive labour effort. It can easily take 200 hours of developent to make one hour of content, and even with authoring tools a ratio of 100:1 is considered excellent.

In training settings, (inside large corporations, for example), content is often custom-made, and even though long-term savings can cost-justify investment, the high front-end cost of content development can appear prohibitive. In a recent survey of computer-based training in 64 firms, the most serious problem assocated with CBT was cost/time required for courseware development.(4)

There are a number of means to decrease or offset the high cost of content creation. Authoring tools to make content more quickly are described in Chapter Three. Also, as discussed earlier, there has been an emphasis on merchandising content after it has been developed, through resale or licensing.

A major consideration with the resale of content in the training marketplace, however, is the need for custom-tailored material. Organizations may need applications that fit their workplaces specifically. In the survey of training in industry referred to above, the major complaint about available CBT systems was that they "require too much customization for each application".(5) Still, even with customization the cost reductions in purchasing ready-made content can be substantial. Also, in some industries (such as the telephone industry) the equipment used is very similar from company to company. There is also a general trend in training towards the use of "generic" sets of skills, as Chapter Five mentions.

In the education world, the situation differs. Commercial software packages are available for microcomputers in schools as mass-market products, manufactured in large numbers and sold at low costs. In Canada, the easy availability of low-cost content from the U.S. brings certain cultural policy questions. Historically, with school textbooks, it has been felt important to encourage indigenous material. (School textbooks are in fact the only category of books where Canadian products sell more than imports). A similar concern can be expected with computer learning applications.

Content creation thus becomes a matter of policy: unless schools are to purchase packages created elsewhere (the most economical course of action), some form of encouragement is needed for content development in Canada. The provincial government in Ontario, for example, has budgeted millions of dollars over the next few years to encourage high-quality Canadian material. Ontario is also making use of several means to offset content creation costs, such as: authoring tools; the use of a production centre; and arrangements that allow suppliers to merchandise their products outside the province.

ii. problems in microcomputer content supply Because software for microcomputers is a mass market, based on high-volume and low-priced sales, a software manufacturer needs to reach numerous buyers conveniently. The user, meanwhile, is anxious to have a convenient supply good quality content. The conditions of software supply, however, have been fraught with problems from both perspectives. These problems have included poor quality, copyright infringements, disorganized supply channels, and incompatibilities.

(a) quality The quality of much educational software has been lamented and, as an earlier section discussed, critisism has fallen both upon the content created by teachers themselves and by professional programmers. An increased prinessionalization of content authoring has not been able to assure improved quality so far.

Three main avenues are being emphasized for improving quality presently:

(1) evaluation;

(2) the use of authoring teams (discussed earlier); and

(3) increasingly intelligent systems.

Regarding evaluation, "peer review" (i.e. review by other educators), more extensive testing, and the involvement of teachers in the design phase of authoring are some of the means suggested to improve content quality. "Formative evaluation", where feedback from users--including children--is incorporated in an ongoing design process is another recommended approach. Regarding intelligent systems, advances in AI approaches require not only technical improvements but major efforts in instructional design and cognitive psychology as well.

(b) copyright

The amateur software created by teachers was "public domain" material: that is, no party expected copyright reimbursement. Copies could be made wthout second thoughts, and teachers exchanged material without expecting money to change hands as well. To a commercial softwere publisher, however, the tendency for microcomputer users to copy diskettes is a serious problem. Even with successful software products, thousands of pirated copies are in use that bring no revenues to the authors.

There is no clear solution in sight to copyright difficulties. A number of "technological fixes" have been considered, such as making floppy diskettes that do not allow copying. But microcomputer users keep back-up copies of programs as a standard practice, and teachers like to copy programs and then make their own modifications. Furthermore, computer programmers are ingenious in working their way around security barriers.

There are other means to reduce copyright problems besides trying to prohibit copying. Licensing arrangments (or "right to copy" agreements) can allow all members of a given group to use and copy material; for example, several provincial ministries of education have memberships in the Minnesota Educational Computing Consortium to use MECC software.(6) Special lease/purchase arrangements can also be made for multiple copies--by school districts, for instance. A mixed public-domain/commercial outlook is also appearing: a provincial ministry, for example, could develop content that was free to any teacher in the province, but that was exported commercially.

Another approach focusses on the conditions of content supply, suggesting that if it is convenient and inexpensive to get content, the motivation to copy will decrease. From this point of view, telecommunications delivery of content by networking can reduce the tendency toward illegal copying.

Better legal protection of copyright is also urged. Under the present law, there is little penalty for copyright infringement. Revisions to the copyright law were proposed in May 1984 (7) that would introduce more favourable terms for software suppliers.

(c) disorganized content supply

Teachers have been vocal in the past about frustrations in acquiring content. Commercial software retailers have not carried a great deal of educational software; also, their shelf space is too limited to carry all the software available and only fast-selling items are left on display. Often, software is ordered from sources listed in educational software catalogues, and once the content reaches the teacher it may be disappointing. As solutions to these difficulties, teachers have suggested libraries, standardized evaluation techniques, clearinghouses, pre-view facilities and exchange networks. The content supply scene has been a chaotic one, and virtually all provinces have explored ways to organize it through clearinghouses and other means.

iii. Incompatibiltiies

Incompatibility is a problem that segments the marketplace: content developed for one manufacturer's equipment cannot be used on that of another. This most dramatically affects the microcomputer market, which is based on mass sales. From the point of view of the software supplier, the market is fragmented by different hardware purchasing patterns. Meanwhile, school boards are unhappy because they become locked into the use of one hardware system: once software has been purchased for their first machine, they are tied to that manufacturer and model if they wish to continue to use the software they've bought. Provincial ministries of education find their planning complicated by the fact that not one but three major types of microomputers are in use (--Apple, Radio Shack, and Commodore, soon to be joined by the Icon in Canada).

Incompatibility is a major problem and even if a program is written in the same language (such a BASIC) it can't be taken from a Radio Shack computer, for example, to an Apple. Furthermore, most manufacturers see advantages in maintaining these incompatibilities: Apple Computer Inc., for instance, enjoys an advantage in the educational world because there is a considerable amount of content for Apples that will not run on other microcomputers. A further level of incompatibility occurs between different authoring languages. Code written in CAN, for example, would have to be completely re-written in NATAL.

Three main approaches are being taken towards incompatibility:

(a) standardization

(b) conversion

(c) authoring techniques

(a) standardization Standardization of hardware has been encouraged in most provinces, either by formal specifications, special purchasing agreements with a particular manufacturer, or arrangements to use software that runs on a particular machine.

Standardized programming and authoring languages are other possible approaches. However, there are two problems with the idea of a standard authoring language: (a) the diversity of the marketplace, where many programming languages and authoring tools are in use; and (b) the risk that technical advances (such as increasingly intelligent CL) may be inhibited.

Flexibility is critical in computer learning development.

Ontario's educational software project, for example, has taken the position that software must be written in any one of a number of popular programming languages, (such as BASIC, Pascal, or "C"). The choice of authoring language is considered less important and the use of several authoring systems is being encouraged.

(b) Conversion

Conversion means moving material from one machine, or one language, to another one. Part of this process can be automated with "portability" software. However, completely automated transfer is less likely to occur than a partially automated process that includes improvements to the material. Such conversion might take from 30% to 40% of the time needed to write the application "from scratch".

(c) Authoring Techniques

Authoring content can be done in a way that minimizes the portions of a program that have to be changed to "port" the software from one machine or language to another.(8)

Another strategy to avoid incompatibility problems is "upwards compatibility": to ensure that, as one model made by a manufacturer is superceded by another, software can be passed on to the second system. Still, there will be compatibility gaps because of technical advances--from 8-bit to 16-bit microcomputers, for instance.

Communications networks can also bridge compatibility gaps. When content is stored in a central database, any kind of terminal that can connect to the database can share that material. Networks such as The Source and Compuserve (mentioned in Chapter Three) can be accessed by a large number of types of microcomputers. Also, two early CL systems (PLATO and TICCIT) were based on networks which originally could use only special terminals, and now can be used by IBM microcomputers as well.(9)

iv. Shortage of Expertise

Because CL's period of growth has been recent, there are few individuals with experience and expertise. In the educational world, a particular problem is the lack of familiarity with microcomputers among teachers. This is a major factor that will restrain both the extent and quality of the use of computers in schools, and the need for teacher training is often emphasized.

Also, there are few people with skills and experience to author content. In general, higher levels of expertise are in short supply: to author content, to train educators in the uses of computers for learning, to set up infrastructures such as clearinghouses and production centres, to develop new authoring tools, to work on basic research projects--to play roles in all areas of the advancement of CL.

5. Five Major CL Systems

Until quite recently, most development of computer learning took place at a small number of centres working on major specialized systems. PLATO, TICCIT, NATAL, CAN and LOGO are described briefly here. In all cases, early work was supported by government, typically in a post-secondary educational environment. Funding was given as support for a new means of education; only later did a transfer to industry occur and many years of r&d preceded commercialized products.

i. PLATO (Programmed Logic for Automated Teaching Operations)

Both PLATO and TICCIT, the two earliest CL systems, embodied the time-sharing model of computing that prevailed when they were designed. A central database was accessed by terminals that had no independant capabilities. PLATO was the epitome of the large-scale remote network, connecting hundreds of terminals across the country through telephone lines. TICCIT was an example of a local area network. Both systems have changed, to emphasize microcomputer capacities, and also to connect to machines other than their own special hardware.

PLATO (and TICCIT also) has been a complete computer learning system, with its own hardware and software, (including an authoring language, TUTOR, and authoring system, PCD-2), and special terminals. It has been remarkable for its bank of thousands of hours of content built up over the years, and for an extensive network that has connected users around the world to PLATO centres.

Work on PLATO began as early as 1961, and involved the University of

Illinois and Control Data Corporation. In 1972 (after a report on "Factors Inhibiting the Use of Computers in Education"), the National Science Foundation awarded $10M to the University of Illinois for PLATO Development. Over the years, Control Data Corporation's investment grew; CDC has spent over $1 billion on PLATO development, and since 1976, has marketed PLATO worldwide.(10) CDC has added vocational and professionally-oriented training courses to PLATO's academic library, and (in 1982) had over 6000 terminals in place serving some 100,000 users. Users access PLATO through a telecommunications network with centres in a number of countries worldwide. A large user of PLATO could also purchase its own CYBER computer, made by Control Data (for a cost of some $2M). In Canada, for instance, there are PLATO systems at the University of Alberta(11) and the University of Quebec, as well as at the Control Data Corporation in Toronto. CDC also operates PLATO learning centres, where individuals can pay to access PLATO for training on a course-by-course basis. Also in Canada, CDC has set up a non-profit institute for youth job training programs with funding from the federal government (--see Chapter Five).

Despite the large number of PLATO terminals in use, only in 1983, did PLATO show a profit for CDC. A major problem has been that using the PLATO network was expensive. Time-sharing over distances is costly, as was the special touch-sensitive plasma screen necessary to use PLATO in the past.(12) More recently, Control Data has focussed on microcomputer capabilities, first through its own system, MicroPLATO, and also by accomodating IBM personal computers.

CDC has also shifted its thinking about PLATO to place more emphasis on PLATO's library of material, publishing its content for use on other systems as well as selling its own hardware and subscription services. Ontario's microcomputer project, for example, is arranging to use PLATO material.

ii. TICCIT (Time-shared Interactive Computer-Controlled Information Television)

TICCIT's history began in the late 1960's at the MITRE Corporation (a non-profit research organization in Virginia). In 1972, at the same time it awarded funds to PLATO, the National Science Foundation also gave $6M to stimulate TICCIT development. In 1976, Hazeltine Corporation acquired the commercial rights to market TICCIT systems, which have been sold as "turnkey" systems including both hardware and operational software to author material.

TICCIT used a local area network and special purpose terminals. A wideband cable network connects up to 128 terminals to a central minicomputer. The cost of a TICCIT system (using 20 terminals, a Data General minicomputer, and modified Sony tv sets) has been high: approximately $500,000.(13) More recently, MicroTICCIT offers the ability to connect with IBM personal computers, both on a local and a remote basis.(14)

TICCIT has highlighted both an authoring language and an authoring procedure with a built-in course structure designed around rules, explanations and tests. TICCIT has mainly been used in U.S. military applications and some educational settings at the college level. In Canada, BC Tel (The B.C. Telephone Company) has been a major user of TICCIT for industrial training. Its training centre has formed a separate group, Microtel Learning Systems, that markets both its own courseware and turnkey TICCIT systems as well.

iii. NATAL (National Authoring Language)

NATAL is an authoring language that was developed in Canada to reduce the difficulties in sharing content among different languages and machines. NATAL's goal was a standard language implemented on a variety of computers. Canada's National Reserach Council (NRC) formed a special body, the Associate Committee on Instructional Technology (ACIT); in 1972, ACIT issued functional specifications for a programming language, and development on NATAL began.

In 1979, Honeywell Ltd. was selected to transfer NATAL from government labs to industry. With NRC support, Honeywell implemented NATAL on several large computers (--DEC, IBM, and Honeywell's own Level 6 minicomputer). NATAL can also be used with a wide variety of terminals. However, the Honeywell system required to use NATAL is a costly one. Hardware to support 16 to 20 users will probably cost at least $400,000, while the NATAL software would cost a further $50,000 or more. (1982 estimates).

Honeywell Ltd. is a subsidiary of the U.S. firm Honeywell Ltd. (U.S.), which also owns part of the European firm CII Honeywell Bull. While a Canadian manufacturer might have been preferred by the NRC to commercialize NATAL, no Canadian firm made the size of computer that NATAL required. Honeywell offered the possibility that its Canadian company could become a centre for computer learning, acquiring world product mandates within the Honeywell group. Honeywell also had the necessary funds to sustain NATAL's growing pains and to launch major marketing campaigns--as it did with CAN, discussed below. However, Honeywell has made no commercial release of NATAL at this time.

A number of centres across Canada have used NATAL by linking to the NRC computer, at the University of Victoria, for example, and in the Canadian

Canada Forces training base at Trenton.

Recently, another version of NATAL has appeared: MicroNATAL, developed by a Victoria-based company, Softwords. MicroNATAL is a reimplementation of NATAL that can be used on a number of microcomputers, including the Icon and IBM and its look-alikes. MicroNATAL can also be used by the larger VAX computers common in universities and colleges.

iv. CAN (Completely Arbitrary Name)

Work on the CAN language began in 1967 at the Ontario Institute for Studies in Education. The main CAN software at present includes: the CAN-8 Authoring Language; EASSy (Educator Automated Authoring System), which generates either CAN-8 programs, Telidon databases, or a master for optical videodiscs; the CANNET network processor, a communications system that links CAN-8 computers; and GAP, a Graphics Authoring System.

CAN has been used for several educational projects in Ontario, and considerable CAN content is available. The Individualization Project, for exmaple, produced a number of college level courses, and a project in Ontario secondary schools created material for the intermediate mathematics curricula. This content can now be acquired on a commercial basis from the OISE. Networking between different campuses has also been emphasized.

A significant event some years ago was the shift of CAN to private enterprise. CAN-8 was developed not by the OISE, but by HOMECOM Learning Systems Ltd., a private company.(15)

Rights to market CAN-8 in North America were acquired from HOMECOM by Honeywell Ltd., and CII Honeywell Bull has marketed CAN in Europe. CAN-8 is implemented the smaller of the Honeywell Level 6 minicomputers, and a system to support 128 terminals would cost about $100,000 (in 1982). Honeywell also made an arrangement to promote OISE courseware. Thus Honeywell held the rights to the two major computer learning systems developed in Canada. More recently, however, HOMECOM is marketing CAN-8 itself (still using Honeywell hardware).

Ontario's software project (described in Chapter Seven) is attempting to implement CAN on the Canadian-made Icon microcomputer; however technical difficulties are occuring (in mid-1984).

v. LOGO

LOGO proponents have made up the philosophical vanguard of computer learning, proposing not only that the computer should be a creative tool for the learner, but that it should be used for new forms of education entirely. The attitude is nothing short of visionary:

> The first instinct of educators is to couple the new technology to their old methods of instruction. My vision is of something much grander. So I dream of using this powerful new technology not to improve the schools we have always known (and, to be honest, hated) but to replace them with something better. I don't believe that this something will look anything like what is now known as "Computer-Aided Instruction." I think it will be more like the growth of a new culture, a computer culture, in which the presence of computers will have been so integrated into new ways to think about ourselves and about the subject matters we learn that the nature of learning itself will be transformed.(16)

This is Seymour Papert's vision and he is the mentor in LOGO devleopment. LOGO thinking is based on the work of the Swiss psychologist Jean Piaget, who studied the ways in which children acquire concepts or "powerful ideas." Papert studied with Piaget, and then set up a lab at MIT (Massachusetts

Institute of Technology) in the 1960's. The National Science Foundation contributed early support.

In LOGO thinking, the emphasis is on learning without teaching, or "Piagetian learning", where new ideas are acquired intuitively and not through formal or didactic methods. With LOGO learning, there is "no threshold and no ceiling." Papert is an iconoclast: not only does the learner control the use of the computer, he or she does so without the curriculum, grades or quizzes that characterize the formal education system. To quote:

> In many schools today, the phrase "computer-aided instruction" means making the computer teach the child. One might say the computer is being used to program the child. In my vision, the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology, and establishes an intimate contact with some of the deepest ideas from science, from mathematics and from the art of intellectual model building.(17)

It is a tenet of the LOGO approach that the computer be under the individual's control, as compliant and ordinary as a pencil:

> ...the pencil has many uses: it is used to scribble, to doodle, to draw, to write, to work sums, or to chew on. It is used for illicit notes as well as for official assignments. I see the computer in the life of the child as equally ubiquitous and equally versatile.(18)

LOGO's emphasis has been on young children, as young as three and four. LOGO creates "microworlds" with agents that the child directs, and processes the child explores. The idea is that within a world such as "Mathland" (where "math is spoken"), one can understand math as naturally as one learns French in a French-speaking country.

LOGO itself is a sophisticated programming language that is accessible enough for young children to write programs themselves. At present, LOGO is mainly associated with the world of "turtle graphics" or "turtle geometry", through which children explore geometric shapes and relations. The "turtle" is a small marker on the screen (--originally a mechanical turtle moved about on a magnetized floor). Simple programming instructions move the turtle on the screen and create shapes and patterns easily.(19)

LOGO software is being marketed by LOGO Computer Systems Inc., a firm based in Pointe Claire, Quebec. There is also a LOGO Learning Centre in New York, which has been funded by the National Science Foundation to train teachers in using LOGO. Another centre of activity is the Lamplighter School in Texas, a model "school of the future". In 1982, Papert and others in the LOGO group at MIT went to France to participate in the Centre Mondiale project (20)funded by the French government to develop new approaches to the use of computers for learning. They have since returned to the U.S., and the Centre Mondiale has not been prominent recently in CL.

LOGO software is available for all major microcomputers. Also, NABU Manufacturing Corporation, of Ottawa, has been offering LOGO to cable-tv subscribers.(21) NABU's venture underlines the point that while LOGO is being used extensively in schools, it is equally likely to be used on home personal computers.

PLATO, TICCIT, NATAL, CAN and LOGO are the major systems developed in the few decades of computer learning history, and in each case development began in the sixties and was a lengthy process. Many early ventures fell by the wayside, and several large corporations (such as Time Life and General Electric) began projects that were soon abandoned. CL was sustained by public sector support, as r&d took place in educational institutions or government labs for years before a commercial phase.

Manufacturers of large computers have generally offered some CL capabilities,(22) but have not extensively promoted computer learning. IBM is a unique case: IBM developed the first authoring language ("Coursewriter") and an educational system (Interactive Instructional System), but did not choose to support the long years of costly r&d without profit that the major CL projects required. Now that the market has become more significant, IBM has equipped its personal computers with certain capabilities, such as the PCIS authoring system, and a networking capacity with IIS.

In the last few years, the microcomputer market has become increasingly important. The major systems described here have adapted to this change by developing microcomputer capacities. In addition, there has been a new generation of entrants in computer learning as interest in creating applications for microcomputers has grown.

6. <u>A Proliferation of Software Suppliers</u>

Until recently, there were few centres of activity in computer learning in either Canada or the U.S. In Canada, a handful of experts were scattered across the country, some affiliated with univerisities; and a small number of universities had CL centres.(23) Even in the U.S., a relatively small number of players have stood out: MECC (the Minnesota Educational Computing Consortium); a few clearinghouses, such as CONDUIT and MicroSIFT; and a number of firms that have specialized in CL products and services, such as WICAT Systems Inc., and Courseware Inc. (See Exhibit 2-1). New entrants, however, have been drawn in increasing numbers to the area.

In the U.S., a proliferation of software companies have sprung up to make

EXHIBIT 2-1

OTHER MAJOR CENTRES OF ACTIVITY IN THE U.S.

MECC

MECC (the Minnesota Educational Computing Consortium) has operated an educational network linking almost each school and college in the state to centralized computer resources. MECC was established in 1975 and originally its central computer was accessed over telephone lines by computer terminals. Gradually microcomputers began to be used in schools, and over 1000 Apple's were in use in 1982.

MECC has emphasized content development, and content is generally considered superior to most commercial products. Applications are developed by staff or culled from the user community. MECC has actively promoted its software outside the state, and several Canadian provinces have arranged for MECC material to be used in schools. Most software is for Apple's, but increasingly material is becoming available for other systems as well.

MECC's annual budget was $5.6M in 1981. Special projects, such as a high school course on videodisc, received $300,000, and $3.76M was budgeted for timeshared computing, in-service training, content development and distribution. MECC also had a large grant to develop learning packages for computer literacy in that year.

CONDUIT

CONDUIT is a non-profit organization that distributes post-secondary educational software through a catalogue-order system. (One catalogue is for BASIC and Fortran programs; the other is for microcomputers of a variety of makes). CONDUIT was originally supported by the National Science Foundation when it began in 1981, and later became affiliated with the University of Iowa.

MicroSIFT

MicroSIFT is a clearinghouse that provides standardized evaluations for teachers about educational software. It began in 1980 at the Northwest Regional Educational Laboratory in Portland, Oregon, with a grant from the federal National Institute for Education.

Specialized CL Firms

WICAT Systems Inc, based in Utah and New York, grew out of a research institute and was founded in 1980. WICAT particularly was involved in early work on videodiscs, mainly through projects for the U.S. military. The company now offers a number of hardware and software products in addition to client services such as videodisc tutoring, instructional design and training analysis. WICAT also operates a non-profit educational institute for curriculum development and research, using a "laboratory" elementary school.

Courseware, Inc., similarly offers a wide range of CL products and services. Also, the Human Resources Research Organizaiton (HumROO) has specialized in education and training systems for many years. It too has worked with the military, including videodisc projects.

applications, inspired by the growing market of microcomputers and the low start-up costs needed for a software business, plus the growing market of microcomputers. Many such firms are producing "educational games", a broad term for entertaining software with a loosely defined "educational value", directed primarily to the home market. Spinnaker Software leapt to success with "Snooper Troops", where young children unravel mysteries; Bank Street Writer is another success, made by Broderbund Software, a developer of video games.

In Canada, most software action has centred around the Ontario Ministry of Education's projects to support software development (described in Chapter Seven). The Ministry has received hundreds of responses to its calls for proposals, from software houses, publishers, individual entrepreneurs, institutions, and combinations of these parties. Often, teachers have teamed up with programmers to form small teams. (If individuals are based in educational institutions, they carry out their projects on a private sector basis).

A particular trend is for book publishers to extend their print activities into software products. A number of educational and general book publishers in the U.S. have followed this pattern. Some publishers have signed agreements with specific microcomputer manufacturers--a difficult choice in a market where incompatible equipment is a central problem. McGraw-Hill Book Co., CBS Publishing, and such educational publishers as Addison Wesley Publishing Co,. Random House Inc. and Scott, Foresman and Co. are among those who have moved from print to software. Many computer learning programs may be linked to books--using characters from children's books, supplying case studies and simulations to accompany textbooks, and so on.

In Canada most publishers are U.S. subsidiaries. McGraw-Hill Canada, for instance, has expressed an interest in CL publishing--as has its parent company in the U.S. It is likely that, unless Canadian-made material is encouraged by policy, the tendency will be for subsidiary firms in Canada to repeat the content published by their U.S. parents, as has occurred in the print trade. One example of a Canadian publishing firm actively involved in CL is a Victoria-based company, Press Porcepic.(24)

Because software firms can be started at relatively low cost, the number of small companies has multiplied rapidly. In 1983, there were over 1000 firms in Canada supplying software; 516 of the largest companies accounted for 98% of the total market.(25) Software is a volative marketplace, with "rags to riches" stories and many failures outside the limelight; already in the U.S. some "shaking out" of the educational software area has begun.

As more entrants move into this area, a firm's ability to capture the attention of potential buyers becomes more critical: through commercial marketing, and through channels particular to educational computer learning such as clearinghouses that catalogue and evaluate content.

7. Summary

This chapter offers a general introduction to computer learning. It began with a review of a number of central aspects of CL development:

1. the shift from simple drill-and-practice routines, to an increasing use of simulations, dynamic graphics, and intelligent systems;
2. the distinction between directed instruction that follows a set curriculum, unstructured applications like LOGO, and inquiry-driven

applications with an intelligent "coach" or "guide";

3. a trend in authoring toward the use of author teams, and towards increasingly professional and commercial of content.

The chapter also reviewed several limitations in CL development. At present, the current needs that stand out most visibly in CL are:

1. The need to improve the quality of content, through improved evaluation and through the use of increasingly intelligent systems;
2. The need to decrease or offset the cost of content creation, (through means such as software tools, production centres, and an emphasis on merchandising).

Means to stimulate content production are particularly a concern if Canadian material is to be used in schools, rather than importing easily available and inexpensive software from the U.S.

In addition, there are several problems particular to the microcomputer marketplace:

-Incompatibilities between different machines and languages. Standardization is an important approach to incompatibilities, but care must be taken not to limit technical advances such as intelligent CL. Other approaches include: conversion (as a semi-automated process that often includes the enhancement of the material); and authoring techniques that minimize the work needed to transfer software.

-Copyright infringements. This problem is being addressed by technical solutions to prohibit copying, licensing arrangements, and legislation to increase the penalty for "pirating" software.

-Disorganized supply conditions for educational software. Many of the actions of provincial ministries (described in Chapter Seven) have been attempts to improve these conditions through clearinghouses and other means.

Finally, a shortage of expertise at all levels, (from teachers to programmers for expert systems), is another limiting factor in CL.

This chapter also described the five major CL systems in the past, each of which was the result of lengthy r&d carried out with public sector support. More recently, there has been a proliferation of entrants in the software marketplace for microcomputers.

From the viewpoint of policy to develop Canadian industry, this chapter provides background on computer learning generally, and pinpoints the critical needs and limiting factors at this time. Chapter Three provides further background, about technology for CL.

CHAPTER TWO FOOTNOTES

1. Patrick Suppes, at the Institute for Mathematical Studies in the Social Sciences (IMSSS) began using computers for drill-and-practice in elementary math.

2. In this sample problem, two trains leave two different locations (at specified times and speeds) and are now on a collision course. A controller notices that they are on the same track. How much time is there to prevent a crash? The student guesses the answer, runs the problem, and watches an animated simulation in which trains, clocks, and odometers are set in motion. (Gould, 1981).

3. Educational Technology, February 1984.

4. Kearsley, Greg, and Hillelson, Michael J., "Computer Based Training: An Industry Survey", (1983), Table 10.

5. Ibid, Table 11. This complaint was made by 34% of responding firms.

6. Arrangements vary, but (in 1982) a provincial ministry of education could obtain a membership in MECC for $4000 (plus $250 for each participating school district) whereby MECC would send software to the provincial contact and expect no further reimbursement regardless of use and copying.

7. These revisions were proposed by the Department of Consumer and

Corporate Affairs and the Department of Communications.

8. IMPS (Instructional Management and Presentation System), for instance, is a method that separates authoring into layers of design and development, so that machine specificity occurs only at the last two layers. Godfrey, D., and Sterling, S., (1983).

9. Kearseley, Greg, "Networking Computer Based Instruction," (1984).

10. The University of Illinois offers an independent version of PLATO, supplying academic content to subscribers who tend to be involved in CL development themselves. In 1982, there were 1300 terminals in colleges and universities across the U.S. (LINK, July 1982).

11. A $2.5M system was acquired by the University of Alberta's Instructional Systems Group in 1980. Over 30 courses have been developed and use averages about 10,000 student contact hours per month (1982).

12. Rental of a PLATO terminal to connect with Control Data cost over $1300 a month in 1982. Even if a terminal was purchased, the yearly subscription fee to the PLATO network was some $11,000.

13. Estimated in 1982.

14. In 1982, the cost of this unit was approximately $10,000--the price of the IBM personal computer plus about $3500 for the TICCIT capability.

15. Dr. W. Olivier, principal developer of CAN at OISE, developed CAN-8

as an independent venture.

16. Papert, Seymour, BYTE magazine, June 1980.

17. Papert, Seymour, Mindstorms (1980), p. 5.

18. Papert, Seymour, BYTE magazine, June 1980.

19. As a simple example, with four commands one can make a program that draws a flag shape (--send the turtle forward, rotate it 45 degrees, send it forward a shorter distance, rotate it 45 degrees, and send it forward to complete the flag). By a command that repeats and rotates the entire flag many times, a complex snowflake-like pattern builds up on the screen.

20. In November 1981, president Francois Mitterand announced the allocation of some $18M per year to a world centre for the development of "microinformatique". The project was a brainchild of Jean-Jacques Servan Shrieber, whose book Le Defi Mondial had emphasized the educational needs of the Third World. One of the aims of the Centre was to develop both hardware and software, working with industry, and a particular goal was a book-sized microcomputer that could be sold at very low cost. Also, there were to be pilot projects in the Third World on the use of microelectronics. However, r&d activities have not been prominent to date.

21. NABU's service is described in Chapter Three.

22. For example, Sperry Univac offers ASET (Author System for Education and Training); Hewlett Packard offers IDF (Instructional Dialogue Facility);

and so on.

23. For example, the Universite de Quebec a Montreal and the University of Alberta have Plato centres; the University of Victoria has a lab that has worked with NATAL; and at the University of Alberta there is also an Educational Research Division which has been active in CL for many years.

24. Press Porcepic has a Softwords division that has produced the MicroNATAL authoring language, and also develops courseware on a client and commercial basis.

25. Wills, R.M., et al (1984), p. 113.

CHAPTER THREE COMPONENTS OF CL

Computer learning makes use of several basic components: some form of hardware delivery system; authoring tools (--special programs to create content); the content or learning applications themselves; and in some cases networks for telecommunications links. This chapter briefly discusses these central elements.

It is particularly important to give attention to still-new and less common forms of computer learning, such as videodiscs, handheld units, and "downloading" material to microcomputers. This chapter also emphasizes artifical intelligence, which is still at an early stage of use but which will have a transformative impact on applications. Any planning for computer learning should anticipate technological change.

1. Hardware

Computer learning began during the era of large mainframe computers, but at present the main kinds of hardware being used are minicomputers and microcomputers. As is the case with computing generally, the trend has been towards shrinking size with increasing capacity. Developmental work has been inching toward microcomputers the size of a book.

i. Mainframes to handhelds

Mainframe examples in computer learning continue to exist, both in large organizations (where computers may be in place for other purposes), and in the notable example of the PLATO system. PLATO continues to link hundreds of users to central mainframe computers, but more recently has built up microcomputer capabilities.

Minicomputers tend to be used for CL today when substantial computing power is required--for example, when a large number of users must be supported. Prices vary, but are always a considerable expenditure, ranging from $20,000 up to a half-million dollars.

The low cost of microcomputers (sold for a few thousand dollars) has caused a rush of purchases in schools, and "micros" are also spreading in the home and small business markets. (Virtually any microcomputer can be used for educational applications; most of Ontario's specifications for an "educational microcomputer" are technical improvements that relate to computers generally).

Microcomputers can be embellished in a number of ways that make applications more interesting. Many manufacturers are highlighting colour graphics. Also, input devices other than keyboards can be used: "joysticks" which rotate to move objects on the screen; touch-sensitive screens; tablets that are sensitive to special pens, and so on. Videodiscs and tapes can add tv-like teaching segments. Sound synthesis can be used for learning music; speech synthesis can be used for spoken output, and (slowly) speech-input capabilities are developing.

Devices much smaller than microcomputers can also be used to deliver content, and handheld units may become increasingly important. Already, light and portable computers have appeared to handle tasks such as accounting and light word-processing, and military and special scientific applications are also pushing forward the state of handheld technology. A major handheld success in the consumer market has been an educational product: Texas Instruments' popular Speak'n'Spell, which teaches spelling and plays a word game, with the novelty of synthesized voice. The low cost of such a small unit (under $100) has been a major selling point.

ii. Videodisc Systems

Videodisc systems have received considerable attention for computer learning.(1) "Multimedia" training has become a catchword, and a several large organizations pioneered with major ventures using videodiscs to train. In education, numerous projects have experimented with interactive videodiscs.

Videodiscs are a high-capacity storage medium: each side of the disc can hold 54,000 tv "frames". A computer learning application can mix video segments (such as narrative sequences, to add interest), video illustrations, graphic illustrations, or printed text. Unlike tapes (where the tape must be wound to reach a certain segment), with videodiscs it is possible to switch to a particular frame instantly. Each frame can be held as long as the individual wants to view it. Thus 20 minutes of videodisc in "running time" (about 35,000 frames) could equal six to twelve hours of actual computer learning time.

Consumer disc players for entertainment tv have been sold for as little as $500. However, these units have a very limited "manual" level of interactivity (--such as the ability to switch to a specific frame). More sophisticated "institutional" or "educational" players have been used for CL, and retail at higher prices ($2000 U.S.). These models have microprocessors that can carry out simple programming functions. For greater capabilities, a videodisc player can be interfaced with a microcomputer.

Using a microcomputer to control a videodisc player allows full-scale computer programs to be written to control the presentation of material and to store and analyse student response data. It also allows computer-generated graphics to be added to video material. A number of educational projects have experimented with microcomputers plus institutional disc players.

To date, consumer videodiscs have made a disappointing entry in the entertainment tv marketplace, and also have offered few examples of educational material.(2) The market for institutional disc players has been better established. General Motors launched the use of videodisc for training in 1979 when it bought 8000 units to be used in its dealerships to train salespeople and mechanics, and to give presentations to customers. Ford Motors and Sears Roebuck have been other prominent customers using discs to train employees.

The cost of making content for videodisc reflects not only the high cost of CL but also the price of video production. Very different types of video sequences could be used (--local vs. famous actors, for example--) and costs could vary widely.(3) After authoring, and the costs to produce the master from which copies are made, actual reproduction of the discs themselves is inexpensive.(4)

The Ontario Institute for Studies in Education has carried out an extensive project using instructional videodiscs, and in Alberta there have

EXHIBIT 3-1
TELECOMMUNICATIONS TERMS

downloading	Software is "downloaded" when it is transmitted from a remote source and stored in local memory, typically in a microcomputer.
videotex	Pages of computer-based information are disseminated from a remote source in response to a user's demand. Two-way videotex connects the user to a remote computer by telephone or cable.
teletext	Teletext is one-way videotex, where signals are sent only from the source to the receiver. Pages of information are broadcast in the blanking interval of an off-air tv signal or over a cable channel ("cabletext"). Pages are broadcast in a continuous cycle, and specific pages selected by the user are "grabbed" by a decoder.
Telidon	Telidon is a means of transmitting text and graphics, using computer-programmed geometric instructions to create graphic displays.
satellite	satellite to cable: signals are transmitted by satellite to cable systems for local distribution; satellite-plus-local area network: rooftop satellite equipment is linked to wideband networks within buildings; DBS (Direct Broadcast Satellite): more powerful satellite signals are transmitted to relatively small and inexpensive receiving dishes.
videodiscs	Videodiscs are a high-density medium similar to phonograph records, capable of storing video, audio and data content. Information is stored in tracks, each of which has an address that can be directly accessed. Each side of the disc can store 54,000 video frames.
fibre optics	Information is transmitted as pulses of light sent down hair-thin rods of glass. Capacity is over 1000 times that of present coaxial cables.

been several projects for training at the post-secondary level.(5) Alberta also has a committee to promote the use of laserdiscs.(6) (Optical laser systems use a beam of light to read information from the disc, with no physical contact wih the disc itself).

2. Authoring Software

There are two main types of software in computer learning: applications software (the actual learning programs with which the individual interacts) and system software, the operational programs that enable the computer to carry out basic tasks. Two sorts of system software are particularly important. Portability software moves applications from hardware of one manufacture to another. (Incompatibility between different computers is a major problem, as discussed in Chapter Two, and software to convert content from one system to another more easily is a valuable aid). Secondly, authoring tools are programs that make the creation of content faster and easier. Content creation in CL is a lengthy process, and 200 to 300 hours of development are often required to produce one hour of an actual application.

There are two main types of authoring tools: author languages and authoring systems. An author language is a programming language specifically for making computer learning content. An authoring system, on the other hand, minimizes the programming required to create CL. For example, an author language would offer the programmer a range of commands for a common task (such as structuring a lesson). With an authoring system, such commands would not be needed: the system would supply a standard model for the lesson, or would prompt the author for information about the lesson in small steps. Authoring systems have tried to allow authors with little or no programming expertise to create content.

Most major systems discussed in Chapter Two include author languages. Also, a language called PILOT has been available for a number of microcomputers, and a new authoring language, ENBASIC, has recently appeared. The PASS system is an example of an authoring system, developed by Bell and Howell. PASS uses a predefined authoring format; prompts the author in ordinary English; has capabilities for colour graphics and videodisc and tape; and runs on an Apple microcomputer. Several authoring systems are available for the IBM PC.

While authoring systems can make content creation much easier, their limitiations have also been criticized. Authoring systems typically use prespecified patterns or "templates" for lessons, which speed up production but limit variety and creativity. A pedagogical bias is intrinsic in any authoring system using templates. Also, if an application is simplified to the point that a person can create it with no programming experience, it is unlikely to use the computer's capabilities in great depth. Author languages require more programming skills and effort, but offer flexibility. The tradeoff lies betwen flexibility and ease of use.

Authoring systems have also been weak in handling a number of enhancements for computer learning. There has been a lack of simplified methods for creating graphics, and of convenient means to handle multimedia material such as videodisc. The use of simulations could especially benefit at present from authoring tools.

There are also no authoring systems that handle knowledge-based or artifical intelligence approaches to computer learning. These systems require complex associative databases which are laborious to make, so that authoring tools could be particuarly productive. Such tools could encourage the use of intelligent CL.

3. Content (Computer Learning Applications)

Content is the substance of computer learning: the actual learning applications software with which the individual interacts.

The word "courseware" has been a standard term for referring to applications in the past. In recent years, however, a distinction has been drawn between "courseware" (entire courses of learning) and smaller chunks of content, called "lessonware". Further changes in terms can be expected as the area evolves.

To date, most of the content made for computer learning has been rudimentary; the potential of the computer has scarcely been probed. This situation can be expected to change, with a number of major improvements: an increasing use of speech synthesis, and, most importantly, increasingly intelligent applications.

i. Speech Synthesis

Computers would be vastly more "user-friendly" with voice input and output. Progress is being made in both speech synthesis and the much more difficult area of speech recognition as well.

Current speech recognition technology is still extremely limited: it allows only a small vocabulary; has problems adjusting when it hears different voices; and has almost no ability to contextualize (--to distinguish, for example, between "spirits" as wine and "spirits" as ghosts). Yet its advantages are so significant that systems capable of recognizing fewer than a hundred words have become commercial products.

Speech synthesis (getting the computer to talk) is a much easier task, and "talking chips" are being used cheaply in a number of consumer products. The first talking consumer product was an educational one: Texas Instrument's "Speak 'n' Spell", which taught spelling and played a simple game. Voice products are also appearing that can be connected to common microcomputers.

ii. Artificial Intelligence (AI)

AI programming processes ideas and knowledge instead of numbers. AI programs use if-then rules (--for example, the computer can be certain that if an animal has tusks, then it is not a cat). They also use networks of facts that are linked associately, so that the computer can tell how various pieces of information are related. (The computer can "know", for instance, that both mastodons and elephants have tusks but also be aware that mastodons are extinct). Chapter Two gave a brief introduction to AI approaches in computer learning.

The AI community has been a rarified group clustered within a few universities, contemplating both the nature of intelligence and how it might be imitated by a computer. Now, after years of basic research and with advances in comptuer power, commercial AI products have appeared. Most are expert systems: computerized consultants programmed with an area of technical expertise. MYCIN, a medical advisor, diagnoses certain diseases and prescribes antibiotic drugs; Dipmeter Advisor is a geology expert developed by a major oil services company to interpret data from drilling sites. To create

Dipmeter, reserachers observed a top field engineer every day for six months, to imitate through if-then rules his specific expertise, practical experience, and means of problem-solving. Experts "replicated" by AI have been surprised at the extent to which their "gut feeling" conclusions can be methodicially arrived at by a smart computer. While there are only a handful of expert systems in use today a flood of others are expected, begining in specialized scientific and industrial settings.

A number of early, experimental AI-based systems were produced for computer learning. SOPHIE is an expert in electronic circuitry; it can interact with a student in natural language, and either SOPHIE or the student can ask questions. As the student practices with the simulated circuit, SOPHIE knows what he or she should be trying to do: if a mistake is made, questions will be asked. BUGGY is an expert in the kinds of errors ("bugs") students make in doing simple math problems. WHY, an expert in meteorology, takes the Socratic approach to turoring: if a student overgeneralizes about a cause of weather conditions WHY raises a counter-example.

Chapter Two highlighted a number of characteristics of intelligent or "smart" CL: the use of expert systems; the use of student models (i.e. the computer analyses the student's responses to build a model of what he or she knows); mixed initiative dialogues (the capability for a student to ask questions, so that a two-way interaction with the program occurs); and the ability of the program to understand natural language.

Because AI programs consist of a network of facts, rules and their interrelationships, they are differ fundamentally from the "frame-oriented" structure of conventional CL programs, where content is organized into "frames" (screenfuls of text or graphic displays) that are accessed through branching instructions.(7) Special AI or "Fifth Generation" languages such as LISP or PROLOG are based on relational databases.

At present, a major limiting factor for intelligent CL is the lengthy time required to create an application, which may entail the creation of an expert system as well. (An interesting example here is GUIDON, which built an intelligent tutor onto the existing expert system, MYCIN). Another limitation has been the power of computer resources required. Already, however, a new generation of microcomputers is capable of using LISP. LISP machines are powerful supermicros designed for AI applications, and are still too expensive to be widely used; but given the rapid advances in computer technology, AI applications should soon be possible on machines that are commonly available.

A less direct limitation on the use of intelligent CL is accessibility. (8) Few computer learning specialists, and few computer scientists generally, have access to the tools needed for AI, and it is difficult for designers and programmers to understand the nature of "smart" applications without examining and using actual programs.

The use of intelligent CL will also be affected by improvements in speech processing, and in "intelligent" graphics. Advances in instructional design and cognitive psychology are required as well.

The Japanese are now focusing on intelligent machines in their lengthy and costly Fifth Generation Computer Project. Cornerstones of the research work include: inference powers, associative memory, and powerful hardware (logic chips many times as powerful as the most advanced experimental models, and core memories with a trillion bits of imformation). The achievement of these aims is admittedly uncertain. Yet, even if specific programs fail to reach their targets they will have galvanized research efforts and, it is hoped, will also have resulted in lucrative products en route.

4. network technologies

Microcomputers that use software stored on discs have become increasingly familiar. However, telecommunications technologies can also be used to deliver applications to computer hardware in several ways. This section discusses networks, "downloading", videotext and teletext, and several delivery media.

i. networks and downloading

Computer learning began with network models: PLATO connected remote users to a central computer, and TICCIT linked machines within a local area. As microcomputers developed, the "stand-alone" approach became more prominent. "Standalone" equipment is self-contained: all computer resources and file storage are located in the unit itself, as in a microcomputer. Microcomputers can also be used with telecommunications links of various sorts, and eventually handheld units too will be used both as "standalone's" and in network contexts.

Local Areas Networks (LAN's) are used to connect equipment within a relatively small area, i.e. a clasroom, school, or training centre. In a multiple-user setting, it often makes sense to share computing resources. For example, thousands of dollars can be saved in a classroom or microcomputer lab if student machines are connected to a central disc drive. Such linkages also allow the central unit to collect performance data, such as student test scores.

Remote networks, using telephone lines to connect to a remote central computer, have been used extensively by both PLATO and the Minnesota Educational Computing Consortium. Recently, a number of "electronic universities" have started up using remote networks. For instance, the Western Behavioral Sciences Institute, based in La Jolla, Ca., caters to executives.(9) Also based in California, TeleLearning Systems Inc. will link users to courses offered by different universities, colleges and correspondence schools across the U.S.--at low cost.(10) Another planned service is Ednet, to be offered by National Education Corporation, a large company which runs trade schools and correspondence courses.(11)

There have also been a number of networks for educators to communicate among themselves. For example, in the U.S. ED-LINE has connected school district offices. Quebec was a pioneer in using networks to connect schools to central computers for administrative purposes, and Ontario has plans to use its Education Computing Network, now used for administration, to download software. Also in Canada, the Department of Communications has funded a project called Consortel, a network that will access a database of information about courseware at post-secondary levels.

In addition to such specialized networks, a phenomenum in the computing world has been the growth of several public networks called "information utilities". These networks use telephone lines to connect virtually any make of microcomputer or terminal to hundreds of databases at very low hourly costs (under $10.00 per hour). The Source and Compuserve have thousands of subscribers, and have included a small amount of educational content among their services. Another smaller public network is EIES, which has emphasized computer conferencing.

The use of networks has several advantages for computer learning. First, these networks have solved the problem of incompatibility by interfacing with so many different kinds of machines. Secondly, they offer computer conferencing: users can make entries into a special database that acts like an "electronic seminar" for "discussions" with the teacher, and group interaction also. Networks can offer access to resource databases as well.

However, in many cases the cost of long-distance telecommunications can become prohibitive. An alternative approach is to "download" content: sending a program through a telecommunications link to be stored in local memory, typically in a microcomputer that then acts as a standalone unit. Various technologies can be used for downloading, including radio, tv or satellite signals, as only a one-way connection is required. In Canada, NABU Network Corporation downloads a number of software services, including LOGO, in the Ottawa area using the cable-tv system.(12) In the U.S., cable companies have downloaded video games to subscribers for some time.

ii. Videotex, Teletext and Telidon

"Teletext" and "videotex" were developed as ways of accessing "pages" of computer-based information. Videotex uses a two-way link to a remote computer, usually over telephone lines, and teletext is its one-way counterpart. (See Exhibit 3-1). In Canada, both videotex and teletext have been closely associated with "Telidon".

Telidon is a means of transmitting information using a special type of coding for graphics display that was invented in the Department of Communications' labs in Ottawa. An incipient Telidon-based industry was nurtured by the federal government, which perceived a future growth area in which Canada had a technological lead. The government supported field trials and other incentive programs, and engaged in international standards-setting to promote Telidon abroad. The Telidon protocol for specifying text and graphics was accepted as a standard now known as NAPLPS (North American Presentation Level Protocol Standard).

As a means of delivering pages of content to the screen, videotex and teletext are of limited use to CL. Early development was based on the use of "menus" (presenting a choice of options to the user) and a "tree-structured" database (i.e. the user selects an option that leads to another set of choices, branching further up the "tree"). This structure was generally too limited for conventional computer learning, and intelligent CL will be much more complex. Furthermore, while videotex is associated with microcomputers or special terminals that have keyboards, teletext typically uses the home tv set for a display device and only a simple numeric keypad for input.

There have been a number of experiments in Canada using "tree structure" videotex and teletext for education, mainly funded by the federal Telidon program.(13) In Britain, where the Prestel videotex system is well-established, several educational applications have been offered for young children. (14)

In the past few years, work on videotex has been advancing beyond the tree-structure approach. Also, the term "videotex" is often used to refer broadly to any two-way link to a remote information service, (including such services as home shopping); networks such as The Source and Compuserve are considered to be "videotex". Similarly, a broader definition of "teletext" includes the downloading of entire software programs. It is in these contexts that videotex and teletext become more useful to CL.

Apart from established networks such as The Source and Compuserve, however, the evolution of videotex remains uncertain and the fledgling industry has already re-strategized several times. Telidon, meanwhile, has had more success as a communications protocol than as the basis of a line of Canadian-made products. (Ontario's software project, for example, is using the NAPLPS standard).

At present, the main links between CL and videotex, teletext and Telidon are as follows:

1. Telidon has become the NAPLPS protocol, which in turn is being used in CL applications;
2. videotex networks in the broad sense (such as the Source and Compuserve) can be used as vehicles for CL that have the advantage of computer conferencing, and that remove certain incompatibility problems;

3. teletext, in the broad sense of the word, can be used to download software.

Videotex and teletext can also be used for information retrieval or messaging by educators. The Consortel project noted earlier, for example, is a videotex network that uses Telidon. (15)

iii. Delivery Media

Content can be physically delivered by several technologies, most notably: telephone lines, off-air radio or tv signals, coaxial cable, satellite and fibre optics.

As a means to deliver information services, the telephone system has several strong points: virtualy every home and office has a telephone; and the telephone line offers two-way communications. A major limitation, however, is the slow transmission rate possible by phone. Telephony is "narrowband"(16) communication, meaning that capacity is limited.

A tv channel is a "wideband" medium with substantially more capacity than telephone lines. However, tv channels are rarely available in urban areas, and services such as teletext have generally been "piggybacked" in a spare line (or "vertical blanking interval") of existing tv signals, which has limited the size of a teletext database to a few hundred pages.
Radio signals can also be used to send data, (for downloading, for instance), when fast transmission is not required.

Radio and tv are one-way media, and no responses can be sent from the user to a central computer. The advantages of a 1-way system are that no long-distance charges are incurred and that signals are widely available, blanketing an area. Using satellite, one-way tranmission on a national level is possible.

Cable-tv service is available to two-thirds of all Canadians and to much higher percentages of the population in urban areas. Over 90% of the residents in Vancouver, for instance, subscribe to cable-tv.

Cable is a wideband medium that allows fast transmission rates, and also has multichannel capacity. With two-way cable, "upstream" signals can be sent from the user to the cable centre. Most systems in Canada, however, are not two-way. New cable systems now being laid in the U.S. and Europe (where cable-tv did not develop as early as in Canada) can start out with two-way capabilities, while, in Canada, upgrading is required. Work is underway at several major urban cable systems. As a one-way medium, cable can carry teletext databases of up to 4000 pages and can be used for downloading as well. Cable technology can also be installed in buildings for Local Area Networking.

Satellite technology offers wideband transmission capability over long distances. Satellite can be combined with Local Area Networks or with cable-tv networks. Newer and more powerful "direct broadcast satellites" will be able to send signals to small and low-priced "dishs" (the dish-shaped antennae used to receive signals). Ontario, for example, plans to eventually distribute software to remote schools by satellite.

Fibre optics is a high-capacity technology that tranmits information as pulses of light sent down hair-thin rods of glass. Capacity is over one thousand times that of existing coaxial cable. Some initial use of fibre optics is occurring, primarily for high-traffic "trunk" lines between major cities. However, widespread use is not expected before the end of the century.

An important consideration with delivery media in Canada is the extent to which a given industry is regulated, and whether new services will be authorized or not. In the U.S., for example, several new technologies are in use (such as low-power tv stations and local microwave systems) that are not authorized here.(17)

The cable industry in particular has faced an uncertain policy situation regarding any new information services, and NABU's service downloading software to subscribers has been authorized by the CRTC (the Canadian Radio-Television and Telecommunications Commission) on an experimental basis only.(18) It remains to be seen how satellite will be treated.

Furthermore, the CRTC is not the sole governmental player involved in telecommunications regulation. The Department of Communications has introduced legislation in Parliament several times in recent years. Also, some transfer of regulatory control over cable to the provincial level of government has been urged by most provinces,(19) and it is generally acknowledged that federal jurisdiction does not extend to many new cable activities.

Regulatory uncertainty can affect the interest in new services among established industries and can prohibit new entrants, and as such can indirectly inhibit the development of CL.

5. Summary

This chapter reviewed a number of technical components of computer learning, including: the varied use of mainframe, mini- and micro- computers, and the likely future growth of handheld units; the use of videodisc systems; and the importance, and current limitations, of authoring tools. It emphasized the development of new capabilities which will affect computer learning, such as speech processing, and most importantly, intelligent CL.

AI (artificial intelligence) is especially important as it will have a transformative effect on applications. The limiting factors in the use of AI at present are:

1) the lengthy time required to create applications (a problem that could be addressed by special authoring tools);

2) the power of computing resources required (a problem that is diminishing as more powerful microcomputers evolve);

3)accessibility (--few CL specialists have the access to intelligent applications needed for them to gain experience and in turn create their own programs).

This chapter also discussed both local area and remote networks as possible components of computer learning. Networks can offer a number of advantages for CL, including: the ability to interface with different types of machines, (which can relieve incompatibility problems); computer conferencing; and access to resource databases. Downloading software applications is another useful form of telecommunications, when long-distance costs are prohibitive or when a one-way medium is used.

Videotex, teletext and Telidon have been a particular interest in Canada because of the federal Department of Communications' role in their development. At present, Telidon is being used for computer learning as the NAPLPS protocol for text and graphics; videotex networks (using "videotex" in the broad sense of the word to include information utilities) can be used as vehicles for CL that offer the advantages of networks noted above; and teletext (again in the broad sense of the word) can be used to download software.

Finally, the capabilities of a number of delivery media (telephony, tv, radio, cable-tv satellite, and fibre optics) were briefly described. A particular issue with delivery media is the extent of telecommunications regulation in Canada. Regulatory uncertainly about whether a new service will be approved or not can indirectly affect--and inhibit--the development of CL.

Two major points that emerge from this chapter are the importance of recognizing the diverse forms computer learning may take using different technology, and the rapid rate of technological change. No planning can rely on the status quo; policies should be flexible and encourage advances, and guard against moves that, even inadvertently, hinder development.

FOOTNOTES CHAPTER THREE

1. See D'Antoni, S., (1982) for a review of educational videodiscs.

2. There have been a few instances of learning applications for consumer videodiscs: the "Kidisc", for example, made by Optical Program Associates, teaches such activities as pig-latin and Irish jigs. A major project called "Schoolhouse", (a combined effort of the ABC tv network and a national association of teachers in the U.S.) set out several years ago to produce elementary-level discs for commercial sales, but the project has been suspended.

3. It could from $2500 to $25,000 to make a disc, and a rule of thumb allows $1000 to $10,0000 per videodisc minute. (Kearsley, Greg, (1982)) Ten minutes, however, could be equivalment to several hours of instruction using stillframes.

4. Mastering the disc costs from $3000 to $5000 (1982).

5. Educational Research Institute of B.C. (1982), p. 45.

6. The Alberta LaserDisc Committee includes members from ACCESS (The Alberta Educational Communications Corporation), Alberta Education (provincial government), Alberta Vocational Centre (Calgary), and several universities and private firms. It promotes the use of laserdiscs in education, medicine, industry and entertainment, provides assistance in development, design, and production of discs, and offers technical information and a number of other

services.

7. Kearsley, Greg, "Intelligent CAI: Today and Tomorrow", paper presented at the ACM 23rd Annual Technical Symposium, Gaithersburg Md. June 1984.

8. Ibid.

9. This program is an offshoot of The School of Management and Strategic Studies, and offers a two-year program emphasizing the humanities and social sciences. It uses the EIES (Electronic Information Exchange System) network.

10. Enrollment, including the basic communications software, costs $99 U.S. at retail outlets, while courses range from $45 to $125. Students use a variety of micrcomputers.

11. Courses will arrive by mail, but students will submit papers and questions to teachers via computer.

12. Cable subscribers can rent a NABU home computer plus programs for $29.90 a month. In 1985, hook-ups to commercial microcomputers, such as Apple, will also be possible. NABU has over 2500 subscribers in Ottawa (1984).

13. For example, the OECA (Ontario Educational Communications Authority), in cooperation with the Department of Communications carried out a Telidon and Education project for several years. Typically, teachers created

small "lessons" or games with the help of OECA staff. Some 80 schools in Ontario have Telidon terminals currently (1984), and several projects are going on.

14. Prestel has an interactive program that teaches numbers, and a "painting book" where pre-schoolers make the computer put colours on drawings while they learn simple words. Fiddy, CHECK, Pamela, and Yam, Lloyd, (1983).

15. The Telidon project is funding Consortel through a group called IPATT (The Interprovincial Association for Telematics and Telidon). IPATT evolved out of the Educational Subcommittee of a Canadian Videotex Consultative Committee set up to advise the Department of Communications.

16. The bandwidth of a telephone line is approximately 3 kHz (kilo Hertz) and a kHz is 1000 units of frequency or cycles per second. A single tv channel is 6 Mhz (Mega Hertz) and a MHZ is one million cycles per second. Most cable systems have a capacity of 300 MHZ. New systems in the U.S. are using 400 MHZ and in some cases are laying more than one cable.

17. The U.S. recently changed regulations to allow low-power tv stations to use weak transmission signals to reach audiences within a small radius. Also, "Multipoint Distribution Systems" (MDS) use microwave to sent multi-directional signals within a radius of a few miles. MDS has been used for pay-tv and for data transmission.

18. The CRTC has characterized cable-tv as a "hybrid" industry, positioned between broadcasters and telephone carriers. Like broadcasters, it originates certain types of content, (e.g. community programming), but like a

carrier it redistributes services originated by others. Initially, the cable industry was tightly regulated to "integrate" it with minimal damage to the broadcasting industry. A lengthy debate on the role of cable has persisted, and the regulatory issues are most troublesome with new information services, where the rationales of the past do not apply, and where the cable industry may be in competition with the telephone industry.

19. Quebec has opposed federal jurisdiction over cable-tv, communications, and culture for decades. In the prairie provinces, telephone companies are crown corporations who wish to control cable technology as one technical means among others of meeting provincial telecommunications needs. Also, both B.C. and Ontario have challenged federal jurisdiction over pay-tv.

PART 2 THREE MARKET AREAS

This section discusses three major potential markets for computer learning:

1)education (in schools, and at post-secondary levels);

2) training (in industry or carried out by government);

3) a consumer marketplace, (where packaged content is purchased on a retail basis).

A major difficulty in discussing markets for computer learning is the scarcity of data about CL itself. The period of growth in this area has been brief, and few figures are available for either hardware or software expenditures. It is virtually impossible to give figures for past growth or to predict future trends in dollar amounts.

A second problem with estimates for the future of computer learning is that the potential market areas are themselves not well understood. Computer based training is expected to provide major opportunities in the next few years, yet there is little information about industry expenditures on training by traditional methods. For the consumer market in CL, there is no traditional activity for which the computer could be considered a replacement. The consumer market is the most difficult to predict, and possibly the largest in dollars over time. Forms of software such as "educational games" are a new species of product, in a setting where purchasing patterns are highly unpredictable and prone to sudden fads.

The aim of this section is not to attempt to generate market estimates, but rather to describe three settings for computer learning generally. The following chapters include indications of market size, where available, discuss current uses of CL; and focus on a number of characteristics and trends.

At the same time as consumer learning is evolving, traditional education and training are undergoing changes. At post-secondary levels, many people are taking non-degree courses outside of formal programs with set curricula--courses that interest them, or that help them to develop careers. Learning like this is an informal process of self-development, and a departure from the patterns for which the education system was built. In training, meanwhile, ongoing training (or retraining) is becoming a fact of working life: to use new equipment, to move into new job areas, to keep up with new developments, and so on. Training outside of the workplace will become more common as people seek new work skills, often informally and on their own initiative.

The three markets discussed here are broadly differentiated by the way in which CL products are acquired: in the education marketplace, an educational institution acquires or creates applications, and provides them to students; in the training marketplace, typically an employer supplies materials for trainees (or government provides training for unemployed individuals); and in the consumer marketplace, a retail purchase by the individual consumer takes place.

There will be considerable overlap between these three markets. First, a particular application (such as instruction on how to use microcomputers) could potentially be directed at any or all three of the educational, industrial or consumer markets. Secondly, the areas of education and training are linked because many training courses are held at colleges. Also, the way in which people are pursuing education and training outside of formal programs, choosing courses as they need or want them, is close to a consumer approach to learning. As microcomputers at home begin to be used for informal learning and training, these three markets will blend.

CHAPTER FOUR THE EDUCATIONAL MARKET

Education is an enormous marketplace: annual spending on education represents approximately 8% of Gross National Expenditures, almost all of it supported by government. Over $30B was budgeted for education in Canada in 1984. Two-thirds of this money went to elementary/secondary schools, while $8.5B was allocated to colleges and universities. Spending at all levels is increasing steadily.

Yet despite its attractive size, and the fact that educational settings nurtured computer learning during its formative years, the educational market has been a problematic one. This section discusses four aspects of the education market for computer learning:

1. microcomputers in schools;
2. formal programs in post-secondary education;
3. informal education;
4. special forms of education (distance ed, special ed, language training, adult basic education)

1. Microcomputers in schools

The growth of microcomputers in schools has generated the most public attention for computer learning recently. This section begins with hardware, discussing the growth in units sold, the main machines in use, and the advent of a Canadian-made machine, the Icon. It also discusses software, and refers back to several points made in the introductory chapters, such as the

EXHIBIT 4-1

EXPENDITURES ON EDUCATION IN CANADA

(ELEMENTARY/SECONDARY, COMMUNITY COLLEGES AND UNIVERSITIES)

($M)

	1980-1981	1981-1982	1982-1983	1983-1984
- elementary/secondary	15,328	17,547	19,682	21,526
- post secondary:				
community colleges	1,821	2,070	2,294	2,487
universities	4,442	4,960	5,503	5,999
SUB TOTAL	6,263	7,031	7,798	8,486
- vocational training *	1,287	1,438	1,557	1,864
TOTAL	$22,879	$26,016	$29,538	$31,876

Source: Statistics Canada, Catalogue no. 81-220, Advance Statistics in Education 1982-1983, p. 25.

* Includes: manpower training; federal expenditures in language courses; training in federal penatentaries and reformatories; various training courses set by federal and provincial authorities; and private trade schools, art schools, music schools, etc...

EXHIBIT 4-2

EDUCATIONAL STATISTICS (ELEMENTARY, SECONDARY AND POST-SECONDARY)

	NO. OF SCHOOLS	ENROLMENT	NO. OF COLLEGES	ENROLMENT (FULL-TIME)*	NO. OF UNIVERSITIES	ENROLMENT FULL-TIME	PART-TIME
B. C.	1,895	530,030	21	21,460	6	35,130	16,910
ALBERTA	1,650	464,580	18	21,060	5	38,510	15,320
SASKATCHEWAN	1,070	211,000	3	2,400	3	18,620	9,320
MANITOBA	830	217,410	8	3,760	17	20,900	14,240
ONTARIO	5,400	1,856,000	32	94,170	21	181,700	99,830
QUEBEC	2,781	1,149,920	84	145,190	7	99,100	95,900
NEW BRUNSWICK	470	147,390	9	2,070	4	14,110	4,670
NOVA SCOTIA	587	177,620	13	2,790	10	22,340	6,920
P. E. I.	72	25,440	2	880	1	1,680	670
NEWFOUNDLAND	641	146,880	6	2,320	1	7,830	4,500
TOTAL	15,502	4,946,690	196	296,100	65	434,920	268,290

Source: Statistics Canada Catalogue 810220 Advance Statistics in Education 1982-83 Table 1,3,7 and 8.

* Part-time figures not available.

fragmentation of the marketplace by incompatibility and the poor quality of much material.

i. <u>hardware</u>

Many figures about the potential market for microcomputers in schools have been cited during the rapid growth of the past few years. There are some 75,000 classrooms in Canada, and putting a computer in each class even at a low cost of $1000 would mean an expenditure of some $75M. If one microcomputer per student were purchased at an even lower price of $500, the dollar value reaches $2.5B. Figures such as these paint a dazzling picture of potential growth.

In Canada, schools have moved from very little use of microcomputers five years ago to an estimated 33,000 units in 1983, with 27,000 more expected to be sold in 1984.(1) It is not possible here to give figures for different provinces; these numbers change rapidly, and because microcomputers are bought as local purchases by schools boards, provincial ministries are not necessarily informed of sales. Still, informal "guesstimates" suggest that in several provinces the number of systems will have doubled this year.

In the U.S., schools went from 40,000 units in 1980 to 291,000 by June 1983, with predictions of 2M by 1988.(2) The study that made these estimates tried to foresee some leveling-off point, and predicted that sales would plateau temporarily around 1987, when nearly all schools would own an least one microcomputer and many would have a lab with 20 or 30 stations. An estimate six months later suggested that 325,000 machines where in place, and that 68% of all schools had computers.(3) Distribution is far from equal, however; this study also found that 80% of the richest high schools had at least one microcomputer, while 60% of the poorest schools had none.(4)

Education is under provincial jurisdiction in Canada, and provincial governments support 66% of the costs of elementary and secondary schools.(5) However, school boards make their own decisions about purchasing microcomputers, using their general budgets, and (in some cases) special local taxes or fund-raising.

There are literally hundreds of microcomputer manufacturers to choose from, but three have dominated in both Canada and the U.S.: Commodore, Radio Shack, and Apple Computer. All three are U.S. manufacturers with divisions in Canada.(6) (Bell and Howell also markets an Apple unit with a few enhancements for classroom use). Commodore machines have been most numerous because of their popularity in Ontario, but the mix of systems varies, and in the Western provinces Apple machines have been preeminent. In the U.S., Apple's share of the school market is approximately 30%, while Tandy Radio Shack and Commodore have about 26% each.(7)

Thus the computer market in schools is often described as "fragmented". Three incompatibile systems fracture the market for content suppliers and make educational planning difficult. In Canada, there are ten different provincial approaches to microcomputers in schools, as Chapter Seven describes, and the market is also divided because of language. (In Quebec alone there are over 1M French-speaking students).

In the U.S., hardware manufacturers have attempted to stake out superior positions through "giveaways". The reasoning is as follows: if a school has an Apple, (for example), it will buy Apple content; it will then tend to buy more Apples that can use the same software. As more Apples are bought, content suppliers will make more Apple material. Thus the more units Apple gives away, the more it gains in market hegemony; and market hegemony hinges on the imcompatabilities between hardware that do not allow content to be shared. Apple has made a major donation of microcomputers to California schools (encouraged by special tax credits).(8) More generally, in the U.S. it has been common for commercial firms to donate equipment for educational use.(9) Manufacturers also discount prices from 20% to 40%. As one Apple spokesman said: "Everybody discounts for schools. It you didn't you wouldn't sell any computers."(19)

It is in this difficult and highly competitive marketplace that Ontario made the decision to nurture the development of a Canadian Educational Microcomputer (a CEM). Ontario schools will receive, (on average), a 75% subsidy for the purchase of approved computers; only the ICON, made by a Toronto company named Cemcorp, has met specifications to date. 7500 Icons will be produced by March 1985. Quebec has plans to similarly support a locally-made microcomputer. Both these efforts are discussed in Chapter Seven.

ii. Microcomputer Software

Most of the information about computers in schools concerns hardware sales. While bulging software catalogues are evidence that more and more firms are supplying educational software, there is little data available on content sales. With CL, the computer is essentially a vehicle for content and there is a growing demand for packaged software in education. Relatively few teachers wish to write computer programs themselves.

Earlier chapters considered several aspects of the use of microcomputers in schools. Chapter One noted that teachers have perceived the main benefit of computers to be motivational--i.e., the computer holds the student's attention and is interesting to use. A second factor propelling the use of microcomputers in schools is "computer literacy", beginning with informal exposure to computers at an early age. At high school levels, programming skills are taught. In other words, microcomputers have not been used on the strength of the educational applications available; in fact, the software available has often been less than satisfactory. Quality was discussed in Chapter Two as a problem in CL development, as were the disorganized supply conditions for educational software.

The shortage of good material, and the difficulty in evaluating and acquiring content, have been causes for complaint in both Canada and the U.S., and many hardware purchase decisions are made on the basis of availability of content for a particular make. Pressure has been exerted upon provincial governments by teachers to organize content through clearinghouses, and user groups have formed to share content and set up libraries. The shortage of good applications is a major problem.

This would seem to be a seller's market. Furthermore, Canadian content suppliers could anticipate the kind of preferential policies that have made textbooks the only category of books in Canada where more is spent for Canadian products than for imports.(11) For cultural reasons, Canadian content in school books has been encouraged; the same rationale could be expected to apply to computer learning as it becomes more important.

However, content suppliers face several problems, including the tendency among teachers to copy diskettes, the incompatibilities that break up the marketplace, and the easy availability of U.S. material--(problems discussed in Chapter Two). Ontario has taken the most forceful steps to encourage the production of Canadian-made applications, through a series of projects that directly fund authoring.

2. Formal Programs in Post-Secondary Education

There are over 250 colleges and universities in Canada, as Exhibit 4-2 shows. Formal programs in post-secondary education include students pursuing unversity degrees, and students at colleges and institutes who take either "university transfer" or "vocational/technical" courses. In addition to such formal programs, (which follow a set curriculum and lead to a degree), informal education is considered below.

The 600,000 full-time post-secondary students in Canada may seem a small group compared to the ranks of 5 million school-children, but other factors add weight to the post-secondary market. First, there are hundreds of thousands of part-time students. (See Exhibits 4-2 and 4-3). Secondly, post-secondary education is expensive: while the average expenditure per student in schools is about $3400, more than double this amount is spent for the average student at a university,(12) and sales of post-secondary textbooks total nearly three-quarters of the sums spent on elementary/secondary books (as Exhibit 4-4 shows).

Computer learning in Canada, however, has had a low profile at the post-secondary level, and there has been little of the excitement that has marked the past years of rapid acquisition of microcomputers in schools. The extent of use at any given institute varies; in a few cases, computer learning specialists have built up major projects, but even at these institutions the

EXHIBIT 4-3

PART-TIME COURSE REGISTRATIONS* AT COLLEGES IN ONTARIO

(November to October)

	POST-SECONDARY COURSES**	NON-POST-SECONDARY	TOTAL
1979	142,674	378,074	520,948
1980	161,621	418,937	580,558
1981	174,797	425,825	600,122
1982	191,845	392,972	584,817
1983	211,795	389,738	601,533

* NOTE: The same student could register for more than one course.

** Courses requiring at least High School completion as a prerequisite.

EXHIBIT 4-4

CANADIAN DOMESTIC BOOK MARKET 1979 (ESTIMATES)

Total Market: Canadian Publishers + Imports

<u>Sales</u>

Elementary & Secondary Textbooks	$132.3M	Professional & Technical Books	$43.1M
Post-Secondary Textbooks	89.2M	Scholarly Books	11.4M
Trade Books (General Readership)	241.9M	General Reference	96.2M

Statistics Canada 87-601, <u>Cultural Statistics</u> (1979)

use of CL has not been widespread.

There are no clear channels for any systematic promotion of computer learning in higher education. Each province has a ministry responsible for post-secondary education and allocates both federal and provincial money to post-secondary insititutions; however, each institution acts on its own. The weak use of CL in colleges was examined in Ontario with the following conclusion:

> Many colleges face a dilemma; they are very much interested in using computer assistance in the teaching process, but they need an environment that will help them start.(13)

Recommendations were made for a provincial advisory committee on computer learning, regional resource centres, funding and coordination of courseware, and r&d in the newest technology.

There is a second important aspect to CL in post-secondary education besides amount of use: it is in post-secondary institutes that the expertise for any Canadian industry must be built up. Students much find courses, projects and teachers that teach them how to design and program content. Expertise is in short supply, and for this reason the limited attention given to computer learning in most colleges and universities is unfortunate.

A few universities and colleges in Canada stand out. The University of Alberta, for example, has been offering full-length courseware for some years, and a major project in Ontario developed six semester-length tutorials that have been extensively used.(14)

As these two examples suggest, at post-secondary levels, large computers often have been used for "courseware", as opposed to the smaller pieces of "lessonware" more common with microcomputers in schools. Large computers continue to be available on campuses for other purposes; however, the use of microcomputers can be expected to increase. (For example, a project in California to stimulate content creation for microcomputers was set up some years ago.)(15) Another trend at post-secondary levels is to link microcomputers into "electronic university" networks. Several U.S. examples were mentioned in Chapter Three.

Potentially, a college or univerisity could immerse the student in an environment where computer use is ubiquitous. The University of Waterloo has something of this character: its area of speciality is computer programming, and the campus is stocked with terminals and microcomputers. A few U.S. universities are becoming computerized showcases: Carnegie Mellon University, for example, has a joint r&d project with IBM, and all freshmen will use computers by 1986. IBM also joined with Digital Equipment Corporation to donate $50M worth of support and services to the Massachusetts Institute of Technology for a campus-wide experiment. Such donations by major manufacturers can greatly boost computer learning at post-secondary levels in the U.S.

A particular trend in higher education that may suit the flexibility of CL is an increase in part-time education, especially at colleges and institutes.(16) (National statistics for part-time education at colleges are not available; Exhibit 4-3 gives figures for Ontario alone).

3. Informal Education

Along with part-time education, there has also been a increase in "continuing education": non-credit courses that are not part of a degree-granting program. People take these courses for self-development, to acquire new work skills, or out of interest as a kind of leisure activity.

While is is generally acknowledged that "continuing ed" is a growing area, at present no national statistics are available. In Ontatio in 1979, over one-half of 200,000 part-time registrations at universities were for non-credit courses. Numerous courses are also offered by local school boards; in the fall of 1981, some 230,000 adults in Ontario were enrolled in non-credit courses at school boards.(17) Studies in Ontario have indicated that 75% of all adults are or want to be involved in further learning. (18) Informal education or "continuing ed" is becoming a recognized form of higher education.(19) Statistics Canada is currently carrying out a survey on adult education which should provide more data on this area.

Adult basic education, general interest courses, and informal training are three major areas of informal education.

Adult basic education is a special facet of education discussed in a section below. Enrolment in general-interest courses relates to Canada's increasingly educated population,(20) which has characteristic ways of spending its leisure time. It tends to watch tv less, for example, and goes more often to libraries, museums, and art galleries.(21) Increasingly, people are viewing informal education as a leisure pursuit.

With informal training, people are also taking non-degree courses at educational institutions to improve their work skills. As later chapters mention, skills needs are changing; in response, people are going to classes on their own initiative to increase their job security and mobility, to adapt to a changing labour market, or to move into work that is of greater interest to them.

Both informal education and part-time education exert demands on the educational system for flexibility in time, place and choice of study that computer learning could potentially meet. The proliferation of short courses about microcomputers now being offered outside of educational institutions is an example of a demand for new skills not being met by traditional institutions. Computer stores, software companies and special consulting firms have positioned themselves to meet this new demand.

Informal education is likely to be flexible, without benchmarks for admission, success or failure. This is de-institutionalized learning, pursued by indivudal choice--an activity that could be part of a consumer market for CL.

4. Special Forms of Education

There are several areas of education where the characteristics of the computer may be especially suitable: distance education, special education, language training, and adult basic education.

i. distance ed

One of the main features of computer learning is that it is indifferent to time and place. Computers could be used in distance education either on a standalone basis (with microcomputers using floppy discs), or in a networked model as well. Networks would allow the added advantage of computer conferencing (as Chapter Three discussed).

Teaching by correspondence began as soon as a cheap and reliable postal system was in place. Various technologies have been used over the decades, including radio, tv, videotapes and satellite. There have been a few outstanding examples of distance learning: for example, the Open University in Britain has had tens of thousands of graduates, mainly using printed materials with some radio and tv lectures and personal tutoring. The OU sells its materials world-wide, and has explored new technologies such as videotex and combined microcomputer-videodisc units.

In Canada, distance education varies from province to province. In B.C., for example, in 1982 there were a handful of "distance ed " students at school levels, a few thousand, at three universities, and some 3500 at the B.C. Institute of Technology. The Open Learning Institute (a provincially-funded organization for distance education) had 7500 course enrolments in 1981, and was using microcomputers for an "Introduction to Personal Computing" course. Also, the Knowledge Network of the West (KNOW) provides "telecourses" over an educational tv channel.

Distance education using computers is still a new area. Ontario has included distance applications as a special interest in its current funding project for CL software. Also, several "electronic universities" have started up in the U.S. using telecommunications networks (as described in Chapter Three).

ii. Special Ed A main features of the computer is that it is an extremely patient teacher. The computer has excelled in a number of special education applications, where it can be infinitely patient and allow the learner to set his or her own pace. As Chapter One noted, work has been done with the physically and mentally handicapped, the emotionally disturbed, dyslexics, and "problem learners" who for whatever reasons fail to fit into classroom norms.

iii. Language Training

Learning languages is a major activity in Canada. Numerous "English as a Second Language" (ESL) courses teach basic Engish to immigrants. Also, many children who grow up in homes where no English is spoken need urgent help at school. (For example, 46% of the children in Vancouver have English as a second language, which means that in the classroom children have widely varying degrees of proficiency).(22) Language courses for years have used automated audio tapes for student practicing; the use of computers, especially with voice processing, could be extremely useful for teaching and practicing.

Also, learning French is of interest to English-speakers in many parts of Canada--both adults and students. French is taught in English-speaking schools across the country. It is available, for example, in secondary schools in B.C.; yet little more than half of B.C. elementary schools offer French classes (even though it is acknowledged that the young learn languages more easily). The Canadian public service is also a special market for language training. Some 2300 public servants were trained in French in 1982, while over 600 French-speakers took English courses.

Ontario's software project has highlighted software for both French- and English-as-a-Second Language as a priority area.

iv. Adult Basic Education

Some 20% of the adult population in Canada does not have nine years of school, and even those with schooling may be deficient in basic skills. A large number of adults need training in basic writing, reading and numeric competencies, and community colleges and local schools boards constantly offer a set of courses for school completion and academic upgrading. The computer's flexibility in time and place of learning could be valuable in this form of "adult ed".

5. Summary

This section has examined a number of aspects of the educational settings for computer learning:

1. micrcomputers in schools;
2. formal programs in post-secondary education;
3. informal education;
4. special forms of education (distance ed, special ed, language training, and adult basic education)

In only one sector has CL begun to boom, with the microcomputers in schools. The market for hardware is highly competitive, and has been dominated in the past in both Canada and the U.S. by Apple, Tandy Radio Shack, and Commodore. Now, however, there is one machine of Canadian make, the Icon, and possibly also a new entrant in Quebec as well.

Both these ventures are the result of provincial policy initiatives (described in Part III). Despite the fact that purchase decisions are made at a local level, the school market is affected to a great extent by policy interventions made by provincial ministries, such as subsidies and special arrangements that encourage certain hardware or software to be used.

In the past few years, while the number of microcomputers in schools has grown steadily, the quality of content has lagged behind. Chapter Two described a number of problems in the supply of microcomputer content to schools in addition to poor quality: incompatibility between different machines, copyright infringements, and disorganized supply of material.

For a software supplier, these problems make the market a fragmented and difficult one. Teachers, meanwhile, have been frustrated with the conditions of content supply, and have put pressure on provincial ministries to make improvements. This pressure has been the cause of most of the policy moves described in Chapter Seven. A further policy issue is that affluent school districts may be more likely to have microcomputers than poorer ones.

At the post-secondary level, there have been few examples of universities or colleges in Canada which have emphasized computer learning--a fact which also means that few students have the chance to work on authoring projects that can build expertise in creating material.

Finally, there are a number of trends in post-secondary education (towards part-time enrolment and informal education) that are placing more emphasis on learning at the student's convenience--convenience that the computer could potentially meet). Informal education, motivated by self-development (for basic skills, general interest courses, or informal training to acquire new work skills) is pursued by the individual and is close to a consumer approach to learning. A consumer marketplace for CL is discussed in Chapter Six.

FOOTNOTES CHAPTER FOUR

1. Evans Research Corporation estimates (mid-1984).

2. The Computing Teacher, Oct.1983, p. 6. Predictions by TALMIS, Oak Park, Ill.

3. The Computing Teacher Dec/Jan 1893/84, p. 8. Estimates by Market Data Retrieval, Westport, Ct.

4. Educational Computing Nov-Dec 1983, p. 16.

5. In addition to provincial funds, local taxation accounts for 27% of total school support; federal government, 2.6%; and fees and other sources, 4.1%. (There are a small number of federally-supported schools). Statistics Canada, Catalogue No. 81-208, Financial Statistics of Education 1979-1980.

6. Tandy Corp., based in Barrie, Ontario, is a division of Tandy of Port Worth, Texas; Apple Canada Inc., of Toronto, is a division of Apple Computer In., of Cupertino, California,; and Commodore Business Machines Ltd., of Toronto, is a division of Commodore International Ltd. in the U.S.

7. Educational Computing, Oct. 1983. Figures are for elementary schools; proportions are similar in secondary schools also.

8. Apple Computer Inc. became prominent some years ago with a "Kids Can't Wait" program. Apple worked with state and federal legislators to enact tax

provisions that would provide incentives for corporations to donate microcomputers to schools. Apple's idea was introduced and passed in the House of Representatives (as The Technology Education Act of 1982, H.R. 5573), but Congress adjourned before consideration by the Senate. However, a bill to provide a state tax credit was passed in California. Private companies that gave computer equipment to California public and private schools were given a 25% tax credit of the fair market value of the donated equipment. (The equipment, meanwhile, costs a fraction of its market value to make). The tax credit was made available from Jan. 1983 to June 1984. In 1983, Apple launched a program to donate a microcomputer to each of nearly 10,000 schools throughout the state.

9. For example, IBM donated 1500 PC's in an $8M computer literacy program for teachers; Silicon Valley Systems gave over $100,000 of software to public schools; and so on. At post-secondary levels, IBM and other major companies have donated equipment also.

10. Business Week, Jan. 6 1983. Christopher P. Bowman, manager of education and home marketing for Apple Computer Inc.

11. In elementary and secondary school textbooks, in 1979, Canadian publishers reported $91M net sales out ot total sales (including imports) of $132M. Textbook sales are the second largest category of books in Canada, next to "trade books" or general readership books. Statistics Canada, Education, Science and Culture Division (private communication).

12. Using Exhibit 4-2, the average expenditure per university student was $7500 in 1982, assuming that a part-time student costs as much as a full-time

student.

13. Thorne, Stevenson, and Kellog (1981), p. 4., a report to the Ministry of Colleges and Universities in Ontario.

14. At the University of Alberta, through the Educational Research Services Division, over 26,000 hours of instruction have been given yearly to some 650 students. (Hunka, Steve, 1982). In Ontario, the "Individualization Project" involved the Ontario Institute for Studies in Education, which developed courseware; the Ontario Colleges of Applied Arts and Technology; the Ontario Ministry of Colleges and Universities and the National Research Council. A number of Toronto-area colleges, some with multiple campuses, now use this material.

15. California State University has 19 campuses with 20,000 faculty and 300,000 students. In 1981, a three-year plan was funded with $200,000 to stimulate content development for microcomputers. Apple microcomputers are used both for authoring (using the PASS authoring system) and delivery. THe goal is to encourage content creation in higher education, and the sharing of material. Completed programs and support material will be sent to all 19 campuses for evaluation. Programs will also be sold externally, and funds will support the project itself and provide royalties to authors. A pilot project proved successful in creating interest in CL among faculty.

16. In B.C., for instance, in the seventies part-time and full-time enrollment at colleges and provincial institutes was roughly equal. By 1979-1980, full-time enrollment had risen slightly (to 18,000) while the part-time figure had doubled (to 30,000). (B.C. Post-Secondary Enrolment

Statitics 1979-1980).

17. Globe and Mail, August 17 1984.

18. Ibid. Reference to a study done by TVOntario.

19. For example, see Ontario Ministry of Education, "Continuing Education: The Third System" (1981).

20. From 1961 to 1977, with the baby boom, the post-secondary "boom" of the sixties, and an immigration policy that favoured highly-educated applicants, the nuber of degree-holders in Canada increased four-fold, from 353,000 to 1,272,000. Picot, J., (1981), p. 31.

21. Ibid, p. 58.

22. Vancouver Sun, August 3 1984.

CHAPTER FIVE TRAINING

Training is a major activity in Canada, and includes:

- -training carried out by industry;
- -money spent by government on manpower training programs;
- -training supported by government within the public service;
- -military training; and
- -training by individuals.

The federal government alone spends over $1B yearly on training. However, it is extremely difficult to estimate a total figure for training in Canada. There is little information available about the training carried out within industry, and what information exists is complicated by overlaps between government-supported training and activities supported by industry itself. Training also overlaps with post-secondary education when classroom settings at institutions are used.

A further problem is that costs include not only expenditures for instruction but also salaries for trainees, which typically make up about 50% of total training costs. Finally, even with an estimate of training by traditional methods, it is difficult to estimate the extent to which computer-based training could replace standard methods. (It has been suggested for example, that 5% to 50% of the millions spent on training in the military could involve computers--an estimate that allows for considerable uncertainty).(1)

Despite this uncertainty about market size, and the fact that much greater sums are spent yearly on the education system, training has been viewed as the most opportune market for CBT (computer-based training) today. While the total potential training market may be unclear, it has been proven that large organizations can find computer-based training cost-effective. CBT typically reduces training time by 30%; this represents a substantial cost savings when employees are being paid while training. A further attraction to firms selling computer learning products is that the pattern for CBT often consists of a major purchase of a complete system, including hardware and authoring software, (such as turnkey systems for CAN and TICCIT)--a large and lucrative sale.

This chapter discusses how training is carried out by government and industry. There is also an inestimable amount of informal training taking place, as individuals take courses on their own initiative to upgrade skills or shift to more opportune areas, or to learn how to use new computer equipment.

1. Training in Industry

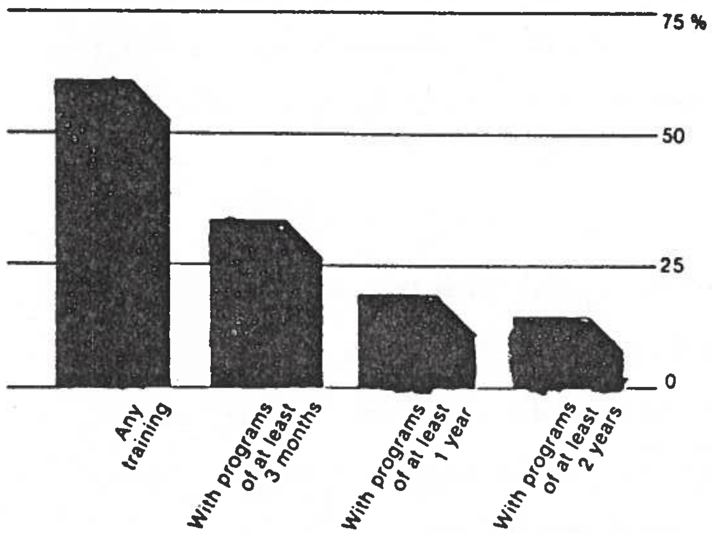
Industrial training can occur on the job, within classrooms "on site" at industrial settings, or in educational institutions. It is variously supported by industry, the federal government, a provincial government, or some mixed involvement of these parties. This complexity makes it a difficult area to describe.

There is very little information available about the extent of training that occurs within industry, and even less about the sums that are spent. The incidence of training programs in industry was studied several years ago, in a

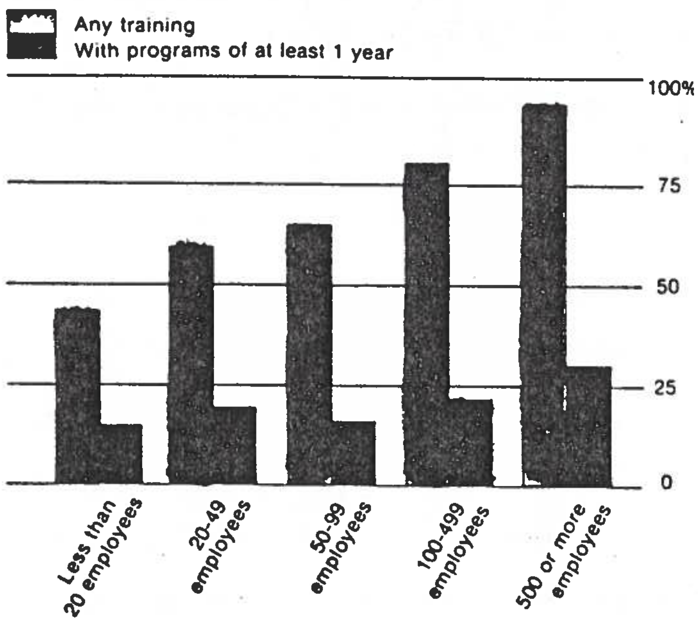
EXHIBIT 5-1

TRAINING IN INDUSTRY
Results of an Economic Council Survey (1979)

The Commitment to Training in Industry
(percentage of establishments reporting training)



The Training Effort by Size of Establishment
(percentage of establishments reporting training)



Source: *Gordon Betcherman (1981).*

a report by the Economic Council of Canada on the supply of skilled labour. While the report laments "the paucity of data on training in industry", it was able to draw on the results of a large survey it conducted in October 1979.(2)

This survey found that over 60% of the responding establishments had carried out some form of training in the past year. (Exhibit 5-1). As might be expected, large companies tended to train more. 20% of the programs cited government aid.(3)

As to the costs of training, "this is a subject on which virtually no information is available, at least within the public domain."(4) Only 34% of the survey respondents provided a figure for costs of training, and there were wide variations between occupations, between firms, and between methods of costing. The most expensive training was for blue-collar workers, which tended to be of long duration (52 weeks and over) and tended to mix both classroom and on-the-job instruction. The average cost per trainee for "product fabrication and repair" was $15,700 (with variations from $1000 to $50,000 per trainee), while a four-week clerical course in the classroom cost an average of only $411.(5)

It has been estimated that sums spent on industrial training in Canada are "in the range of $3B to $15B annually".(6) However, a recent survey in the U.S. suggests that expenditures (in firms with over 50 employees) totals just over $3B. (See Exhibit 5-2). The Canadian estimate could include $1B of government support; it could also include wages for trainees, company overhead and loss of workers' time during training (which the U.S. figures exclude). Still, given that the Canadian market is typically estimated as one-tenth of the U.S. figure, a discrepancy presents itself. It is evident that more information,

EXHIBIT 5-2

1983 BUDGETED TRAINING EXPENDITURES

(U.S. ORGANIZATIONS WITH OVER 50 EMPLOYEES)

GANIZATION ZE BY NO. EMPLOYEES	HARDWARE BUDGETS	OFF-SHELF BUDGETS	CUSTOM-DESIGN BUDGETS	OUTSIDE SERVICES BUDGETS	TOTAL PROJECTED BUDGET
	(Actual $)	(Actual $)	(Actual $)	(Actual $)	(Actual $)
-99	172,264,000	194,603,000	188,905,000	307,096,000	862,868,000
0-499	299,366,000	336,516,000	248,433,000	544,127,000	1,428,442,000
0-999	153,289,000	73,516,000	59,296,000	90,410,000	376,511,000
000-2,499	63,699,000	64,380,000	42,684,000	54,219,000	224,982,000
500-9,999	16,427,000	17,741,000	16,391,000	16,511,000	67,070,000
,000	28,290,000	27,588,000	28,597,000	22,192,000	106,667,000
TAL	733,335,000	714,344,000	584,306,000	1,034,555,000	3,066,540,000

urce: Training magazine, October 1983, pg. 34ff

gures do not include salaries and benefits for trainees and trainers, overhead r in-house activities, "offset money" for employees not on the job actors that unquestionably increase the real expense of training but that e very difficult to report on in a meaningful, uniform fashion".

RDWARE BUDGETS include: expenditures for audiovisual and video equipment, computer hardware, slide projectors, teleconferencing equipment, etc...

F THE SHELF BUDGETS include: expenditures for films, books, published computer-based training programs, prepackaged workshops, etc...

STOM-DESIGN BUDGETS include: expenditures for custom-produced materials such as TV and film production, as well as seminars tailored to the organization's specific needs.

RVICES BUDGET include: expenditures for professional services such as public seminars and training and development consultants including survey data, is needed on training within industry in Canada.

2. The Federal Government and Industrial and Manpower Training

The federal government is involved in training in several major areas, two of which are internal: training its own employees in the public service, and training in the military (both discussed below). It also plays a major role in industrial training. As Exhibit 5-3 indicates, both federal and provincial governments support training programs, but the federal sums are by far the larger contribution.

The Canada Employment and Immigration Commission (CEIC) spent nearly $1B in 1983 on technical and vocational training. On a per capita basis, government spending on vocational training programs in Canada is among the highest in the world. Exhibit 5-5 shows expenditures on training programs in the past few years.

Two major federal programs give money to firms to encourage training within industry, by reimbursing the costs of training and by supporting a share of trainee wages. (See Exhibit 5-4). The bulk of CEIC's money, however, goes to the Canada Manpower Training Program, to "buy seats" in classes for unemployed individuals, and to provide these trainees with financial support.(7)

The workings of the Manpower Training Program are a knot of federal and provincial involvement. The seats in training classes that are purchased by the federal government are bought through provincial intermediaries. This can result in some awkwardness in curriculum planning; there is no way for the federal sponsor to support a course directly.

EXHIBIT 5-3

GOVERNMENT EXPENDITURES ON VOCATIONAL AND OCCUPATIONAL TRAINING

	1978-1979	1979-1980	1980-1981
		$.M	
ANPOWER TRAINING PROGRAMS:			
ederal government	655	690	792
rovincial governments	135	226	246
unicipal governments	-	-	-
ther sources	14	19	23
UB-TOTAL	804	935	1,061
THER VOCATIONAL AND CCUPATIONAL TRAINING:			
ederal government	170	145	147
rovincial governments	56	42	51
unicipal governments	-	-	-
ther sources	-	1	9
UB-TOTAL	226	188	207
OTAL	1,030	1,123	1,268
RIVATE BUSINESS COLLEGES, RIVATE TRADE SCHOOLS AND THER PRIVATE SCHOOLS: FEES	33	32	41
TOTAL	40	43	49

ource: Statistics Canada, Catalogue 81-208, Financial Statistics of Education, Table 25.

EXHIBIT 5-4

TRAINING PROGRAMS SUPPORTED BY THE FEDERAL GOVERNMENT

The industrial training programs supported by the Canada Employment and Immigration Commission (CEIC) are of two sorts. Two programs (CMIPT and CSTP) allocate money to firms themselves to encourage industry to train, while a third (CMPT) buys places in educational institutions for unemployed individuals.

A. Training Through Industry

The Canada Manpower Industrial Training Program (CMIPT) reimburses an employer for training costs and pays a share of the trainee's wages. The employer is responsible for carrying out the training, which could be done on-the-job, in classrooms "on site", or in an institution (if the employer arranged for a course to be offered). The intent is to give seed money and encourage employers to train.

The Critical Trades Skills Training Program (CTSP) is a recent program that also works through industry, to help employers train workers in skilled trades in short supply. It reimburses employees for training and pays all or part of wages for up to two years.

B. Training Through Institutions

The Canada Manpower Training Program (CMTP) is implemented through institutions: the federal government "buys seats" in classes in provincial colleges and institutes or in private training courses. Most trainees on this program are referred through Canada Employment Centres and are jobless. In addition to paying for training, the federal government either pays Unemployment Insurance Benefits or a training allowance to the trainee.

EXHIBIT 5-5

FEDERAL INDUSTRIAL TRAINING PROGRAMS

$M

TRAINING PROGRAM	1979-1980	1980-1981	1981-1982	1982-1983
Training through industry:				
Critical Trades Skill Training (CTST)	.9	7.5	26.7	37.7
Canada Manpower Industrial Training Program (CMITP)	101.3	106.1	111.0	72.5
Training through institutions: Canada Manpower Training Program				
seat purchase expenditures	345.9	395.0	419.9	42.3
Unemployment Insurance for trainees	137.3	157.8	166.3	706.0
other trainee allowances	84.2	103.6	105.7	109.1
SUB-TOTAL	567.4	656.4	692.1	797.4
TOTAL	669.6	770.	829.9	907.6

CANADA MANPOWER TRAINING PROGRAM *	1980-1981	1981-1982	1982-1983
Job Readiness, Work Adjustment Training and Occupation Orientation	13.4	17.7	21.2
Language	41.4	31.2	37.7
Apprentice	55.5	69.2	88.6
Basic Training for Trade Skill Development	51.5	54.4	61.8
Skill Development	204.6	232.2	260.3
TOTAL	366.4	403.7	469.8

Sources: Employment and Immigration Canada (1982), and phone information.

* Sums spent on purchase expenditures. In addition, income supplements are paid to trainees.

The provincial role in training differs across Canada; the provinces support industrial training programs themselves but (as Exhibit 5-3 suggests) of a much smaller magnitude than the federally-supported programs. The provinces, however, could directly support the use of computers to train if they wished; both Ontario and Alberta, for example, have experimented with computer-based technologies. Because of the federal/provincial split in jurisdiction, it would require considerable arranging for the federal Manpower Program to instigate the use of computers for training if it wished to do so.

Another newer federal program, however, can fund the purchase of computer equipment and software development. In 1982, a Federal Training Act was passed to establish a new Training program in Canada.(8) One new component was a Skills Growth Fund, to provide capital assistance for training facilities. The CEIC is able to enter into an agreement with either a province or a non-profit organization, to give financial aid for buildings and equipment, initial operating costs, and development of courses. This potential for a direct role in curriculum development was a change from the past.

The Skills Growth Fund has supported a number of computer-based training initiatives, including:

-a consortium of seven community colleges in Ontario, to develop courseware for ten occupations ($2.6M);

-a non-profit organization (Kanata High Tech Training Association, a consortium of seven "high tech" firms in the Ottawa area), to develop course materials for training staff ($2.5);

-a computer link-up between three Manitoba community colleges, with plans to use computers for distance learning;

-a non-profit organization formed by Control Data Corporation, for Youth Job Core Programs, at the Kirkness Learning Centre in Winnipeg ($232,000), and at other centres across Canada.

In other cases, The Skills Growth Fund has given capital assistance for the purchase of computers; whether this equipment is used for education or other purposes is up to the institution itself. (Ryerson Polytechnical Institute in Toronto, for example, received money for a new facility with computer hardware, and also has been active in computer learning in the past). This Fund has spent $191M over three years (in mid-1984).

The Skills Growth Fund is part of an expanded federal role in training. Because of the federal government's major responsibility in this area, training has become a major policy issue and a much-discussed topic in federal policy circles recently. Broad changes in the economy, and technological change in particular, are exerting new demands on the labour market. Workers displaced by new technologies must be retrained, and at the same time there is a shortage of skilled manpower in other occupations. As Chapter Seven discusses, training has become a policy matter of considerable weight.

3. Training in the Federal Public Service

Another potential market for computer learning is within the public service. The cost of career training activities attended by employees in the federal public service for example was $153.6M in 1980/81.(9) This figure includes $70M for participants' salaries, and was a 39% increase over spending in the previous year. 22% more individuals were trained in 1980/81 and "technical and professional" categories accounted for over half of all training courses. In addition to career training, the Public Service Commisison spent over $298M in official language training.(10)

4. The Military

The military is a special case in any study of computer learning. In the U.S., various military agencies have been catalyst users of CBT, stimulating the development of new technologies. In Canada, the DND (Department of National Defense) has made some use of NATAL, microcomputers and multi-media training; however, this has not resulted in significant support for computer learning, and a major CBT contract for military training was awarded to a U.S. firm.

Training needs in the military can be extremely expensive: in the U.S in 1982 flight training alone accounted for nearly $1.5B, at a cost per student hour of over $330,000, and specialized skills training cost $2.3B at an average cost per student hour of $3400.(11) Overall, the training needs of the U.S. military are enormous: $10.2B was budgeted in 1982.

In meeting these needs, the military has been an influential force in the use of CBT. It has supported new technologies, and particularly developed the use of simulation and instructional videodisc. Transfers of technology from the military to private sector have occurred, and expertise was built up in specialized firms that became leaders in the computer learning field. The military has also supported research in voice technology and artificial intelligence.

The training needs of the military in Canada are more modest, but still substantial: $600M was budgeted for 1981/1982, when the Canadian forces trained over 1200 persons in over 120 trades.(12)

The Canadian military began some investigation of computers for instruction as early as 1972, and during the seventies undertook a small CBT experiment which proved successful. However, "no plans had been made to exploit the program's success", and it was suspended.(13) In 1978 a test course was used at a training school that reduced classroom instruction time by 30% to 60%. This study was expanded to include six more courses, and the National Research Council selected the training school as the test for its prototype NATAL system. The design and authoring of the test courses in NATAL, however, proved lengthy and little actual use of CBT has occured.

In 1981, Canada made a large purchase of CF-18 fighter planes from the U.S. manufacturer, McDonnell Douglas. A major application for computer-based training (with 1500 hours of content) was required, and this prospect created a flurry among Canadian firms interested in CBT. The outcome however was disappointing: a division of McDonnell Douglas received the training contract. No Canadian firms were considered large enough to compete for this contract, worth approximately $5M (--twice the amount of the CBT hardware). More recently, DND let a contract for building new ships in the Navy, and it seems that the CF-18 situation will be repeated.(14) Neither historicially nor at present have the armed forces in Canada played the role of an "engine" in CL development.

5. Training by Individuals

Apart from the training carried out by government or industry, individuals pursue training on their own initiative, both in degree-granting programs and on an informal or non-degree basis. In part, this activity overlaps with the education system (discussed in Chapter Four). Individuals may also turn to private vocational schools, or (in the case of instruction about microcomputers), to short courses that have sprung up at outside of institutions.

There are few statistics available for such privately-pursued training. A Statistics Canada survey on adult education that is now underway should help to clarify this area.

In the U.S., though no national statistics are available, it has been estimated that 2M students enrolled in private vocational training courses in 1983, paying as much as $3.5B in tuition fees.(15) By 1990, fees are expected to rise to $10B. This market is shared by some 8,000 privately-operated licensed schools. One prominent company, National Education Corporation (NEC) has begun using a computer network, as noted in Chapter Three.

The short courses on microcomputers which have been offered by computer stores and other computer-related companies remain a part of the training market for which there are no estimates. Thus the training market, with the extra component of training pursued by individuals (often informally) is likely to be substantially larger than estimates that focus on training by industry and government alone.

6. The Use of CBT for Training

Any indications of the size of the training market still say little about the potential substitution of the computer for training by traditional means. Also, insufficient figures are available for the past use of CBT to predict future trends. Certainly, CBT is becoming more important: a survey of U.S. firms shows that 32.2% had some form of computer equipment for instructional use in 1983--a jump from 18.3% the previous year.(16) 19% had plans to use computers for training in the next year.(17)

Use of CBT tends to be higher in large corporations. A survey of 56 major firms in 1981 found that 50% of the respondents were using computers for training.(18) A similar survey in 1983 showed that only 24% of those contacted had no plans to use computers in the foreseeable future.(19)

There are a number of trends in training that suit the use of CBT. First, there is a trend towards more off-the-job training:(20) more and more training is done in classrooms. Secondly, there is a trend toward "generic skills training", an approach that groups together skills common to a number of occupations. For example, basic principles can be taught in "generic clusters", such as mechanical trades, electrical and electronics, and so on. Generic training can then be followed by specialized instruction in classes or on the-job.

The main recommendation for CBT is that it cuts the costs of training at a time when training by traditional methods is becoming more expensive. Costs to a corporation include instructional staff, materials, and wages for employees; as wages rise, so does the cost of training. If employees must be replaced on the job while they train, this adds more expense; and if trainees travel to instructional centres in another city, costs increase again.

The advantages of CBT in this context are several:

(1) training time is reduced substantially. Conventional wisdom in the industry estimates that learning time can be reduced by 30%;

(2) the student/instructor ratio can be increased;

(3) simulation can reduce the use of expensive equipment by trainees;

(4) CBT can remove the need for trainees to travel to other cities to training centres. It can also allow training to be given at any time--including (with suitable incentives) the employee's own time at home.

Thus CBT make "bottom-line" sense. B.C. Tel, for example, is a company with large training needs that several years ago spent $12M a year training employees. One of its most popular courses is Digital Logic, the basic course taken by employees in dealing with computers. Over 250 students took this course at a cost to the company of $1M a year. Converting the course to computer form reduced the time needed to train from ten days to five. Course development costs amounted to $175,000, and equipment costs for a TICCIT system supporting 20 terminals were $500,000. Thus at least $375,000 savings were anticipated per year, (--more if students completed courses quicker), and it was estimated the system would pay for itself within three years.(21) In fact, course completion was faster than expected so that greater savings resulted.

B.C.Tel's digital logic course is an example of "generic" training that can be used outside of the company that created it. Telephone companies worldwide use similar technology, and the BC Tel Education Centre (now Microtel Learning Services) is selling both its training course and the TICCIT system.

There are numerous other examples of large-scale use of CBT. Airlines have been major early users of CBT: Air Canada has used PLATO for flight simulation, and several other airlines have used computers to train. British Airways, for example, adapted 3500 terminals to train staff in booking reservations; the same terminals were used for day-to-day work. British Airways later marketed its course to other airlines, including CP Air. United Airlines trained pilots on a flight simulator that cost $10M but was still only a fraction of the cost of a real airplane and could be operated at one-tenth of the cost.(22) IBM has used computer simulation in an executive management training program,(23) and Holiday Inn has used computer simulations of hotel operations to train managers in business planning and forecasting.

Most of these examples use large computers where multiple users access central computer resources. They suit contexts where large organizations train sizeable numbers of employees on an ongoing basis. A new trend is starting as microcomputers diffuse in both small businesses and large corporations. Microcomputers could be introduced in formalized training programs, as large CBT systems have been, and could answer ad-hoc needs for instruction as well. It has been estimated (in 1981) that some 750,000 business persons were using microcomputers. (24)

A 1983 survey of of computer-based training in 64 large firms found that, while a substantial number of systems were main-frame based (especially using IBM computers), microcomputers were the dominent delivery system used.(25) While capacity is still limited, (and simulations, for example, might exceed microcomputer capabilities), an increasing use of microcomputers can be expected. A particular aspect of microcomputers within large organizations,is that they can be used without a great deal of internal "red tape".

Microcomputers offer the possibility of not only creating customized material but of purchasing ready-made products as well. Packaged training softw is are beginning to evolve: Courseware Inc., for example, has a "Sales Manager" package to help plan activities "no matter what you sell"; Thoughtware offers a set of general Management Diagnostic programs. Chapter Three discussed the issue of whether training material must be specific to a particular workplace; these software packages are trying to provide generically useful material. In a 1983 survey of U.S. organizations, 29.7% of respondents were using only packaged software.(26) Small businesses could find packaged software especially valuable.

7. Summary

Training is a multi-billion activity in Canada; however, there is a serious shortage of data on how much training is taking place, especially within industry, and at what costs. The training market generally is poorly defined, and is complicated by overlaps with government expenditures, and with post-secondary educational institutions also.

The basic types of training carried out in Canada are as follows:

1. Training in industry--variously supported by industry itself, the federal government, provincial governments, or some combination of these parties. The federal government has two major programs that encourage training in industry by supporting the costs of instruction, and contributing to employee wages.
2. Government training programs. Government also trains unemployed individuals and administers apprenticeship programs. The federal government dominates in this area with its Manpower Training Program; however, because of a split jurisdiction this program

operates through provincial intermediaries.

3. Training in the public service. The cost of career training within the federal public service was $153.6 in 1980-81.

4. Training in the military. Though the U.S. military has been a "catalyst" user of CBT (stimulating technical advances and building up expertise in specialized firms), in Canada the military has not been influential in this area, and has awarded a major contract to a U.S. firm.

5. Training by Individuals. Apart from the training done by government and industry, individuals pursue training on their own initiative. These activities overlap with the education system and also spread outside of it, as people turn to private vocational schools and also (in the case of instruction about computers) to courses given by various firms with expertise. Often this training is informal, with no degrees; like informal education, it is close to a consumer market for learning.

CBT offers a number of advantages that can save money for an organization. Training time is reduced by some 30%, the student/instructor ratio can be increased, simulation can reduce the need to use expensize equipment for practicing, and trainees may no longer need to travel to remote centres for classes. In many cases, the purchase of a major CBT system plus the development of customized applications can be cost-justified, and the prospect of such large purchases has made the CBT market an attractive one.

A new trend is the use of microcomputers for training, both in small businesses and in large firms. In a large company, microcomputers can be used without the internal red tape needed to implement a major system.

Microcomputers can be used not only to make customized applications, but with packaged software available at low cost.

Training has become a pressing policy issue in federal circles, as changes in the economy and the workplace have intensified the need for people to be trained and retrained. A number of initiatives funded by the federal government have used CBT for training; however, as Chapter Seven will discuss, there has been no systematic assessment of whether CBT offers advantages that could help meet national needs.

PART II

THREE MARKET AREAS

CHAPTER FIVE FOOTNOTES

1. Globe and Mail, Oct. 12 1981, "Computer-Aided Learning Becomes a $5B Market."

2. The Economic Council's "Human Resources Survey" sent questionnaires to 4012 firms across Canada in all industries except public administration and agriculture. There were 1354 respondents. See Betcherman, G. (1981, 1982).

3. Economic Council (1982), p. 84. These tended to be longer programs for blue collar workers.

4. Betcherman, G. (1982), p. 58.

5. Ibid.

6. National Research Council, Associate Committee on Instructional Technology (1984), p. 3.

In another calculation in 1980, CEIC estimated that its share of training in industry comprised about 5% of total industry spending on training (based on a survey of training in Ontario). CEIC extrapolated form this data that training in industry cost $2B a year (including a federal contribution of nearly $4B).

7. Manpower training includes the development of specific skills (mainly

in clerical occupations, product fabrication, assembly and repair, construction, and machinery-related trades). It also includes the classroom component of provincial apprenticeships, academic upgrading (Basic Skills Development), and several other programs.

8. Bill C-115, An Act to Establish a National Program for Occupational Training (as passed by the House of Commons, June 22, 1982).

9. Treasury Board of Canada Secretariat (1982).

10. Public Service Commission of Canada (1981) pp. 40, 109.

11. Walter, Brian (1982).

12. Department of Supply and Services, Defence 81 (1981).

13. Belanger, J., (1981), p. 25.

14. National Research Council, Associate Committee on Instructional Technology, (1984), Appendix 3, Report of a Subcommittee on the Development of a Courseware Industry.

15. Business Week, July 5 1983, p. 85.

16. Training, October 1683, p. 39. 39.8% were designing lessons that would be computerized; 34.9% were designing lessons on the computer using computer-authoring; 33.1% were prgramming lessons in a programming-authoring language; and 29.7% were using only off-the-shelf packaged training (p. 52).

17. Ibid., p. 52.

18. Kearsley, Greg, et al, (1981).

19. Kearseley, Greg, and Hillelson, Michael, "Computer-Based Training: an Industry Survey", Table 2.

20. CEIC, July 1981), pp. 168, 172.

21. Ron Kellison, B.C. Tel Education Centre, private communication (1982). See also M. Westrum and R. Kellison (1980) for earlier estimates. it was expected that the TICCIT program would reduce costs per student hour from $23.68 to $13.82 once the system was operating.

22. Globe and Mail, Dec. 8, 1982.

23. Brown, Beth A., (Sept. 1981a). This study gives a number of U.S. case studies, as does Kearsley, G., (1982b).

24. Kearlsey, Greg, et al, (1981), using Computer Decisions, Feb. 1981.

25. Kearsley, Greg, and Hillelson, Michael J., "Computer-Based Training: An Industry Survey", (July 1983). The IBM PC/XT and the Apple II were most prominent.

26. Training, Oct. 1983, p. 52.

CHAPTER SIX THE CONSUMER MARKETPLACE

The "consumer market" for computer learning consists of learning outside of educational institutions or organizations which train employees, and apart from government-supported training programs. In the consumer marketplace, individuals typically buy software applications for microcomputers on a retail basis. In the future, handheld units may also become important.

Sales of microcomputers have been multiplying for several years and show the most rapid growth in the computer industry. For several years, this market has been growing by more than 100% annually. One problem with figures for sales of microcomputers, however, is that "home computers" is sometimes used as a general term, and includes machines bought for a number of settings: for home use, and also for small businesses, schools or large corporations. For example, when it is estimated that 10M "home computers" have been sold in the U.S., and that as many again may be sold in 1984,(1) these figures may include microcomputers in any or all of these environments. In particular, purchases by small businesses and for home use are easily confused.(2) Focussing on home use, it has been estimated that 14M homes in the U.S. will have computers by 1987.(3)

Meanwhile, software sales for microcomputers have also been increasing dramatically. Sales for 1983 have been estimated in the U.S. as

$710M--fourteen times more than two years earlier.(4)

At least three types of computer learning are likely in the the consumer marketplace:

(1) free-form unstructured learning for children;

(2) informal learning and instruction;

(3) and packaged software for training in the use of microcomputers.

Rapid growth in "educational games" software has already occurred in the past few years.

1. Educational Games

One of the earliest CL applications for children was LOGO's turtle geometry, (described in Chapter Two). LOGO proponents have emphasized the idea of "learning without teaching"; LOGO offers highly entertaining activity but, as manufacturers are careful to point out, it is also "educational". LOGO was built on years of serious research on how children acquire concepts. A number of "educational games" have followed the path of combining learning and fun, (although the extent of actual "learning" is often indefinite).

For example, Spinnaker Software Corporation created "Snooper Troops", which "subtly introduces scientific methods by getting the child to unravel mysteries, like finding a ghost in a haunted house."(5) Snooper Troops rose to the No. 9 position among the top 10 microcomputer programs. It gets high marks from educators and at the same time, as a four-year old put it, "It's more fun than Pac-Man."(6)

In some cases, software manufacturers have made arrangements with popular

2. Informal Learning for Adults

The market for informal learning for adults appears more sedate. Three main types of applications are considered here: practical instruction, general-interest learning, and informal training.

Most people at various times need practical "how-to" instruction to accomplish specific tasks. The sales of "how-to" books might be expected to provide some indication of the demand for such material, but unfortunately sales figures for such books have not been segmented from general book sales. (Statistics Canada is now collecting information that will separate "how-to" books). Instructional books have become much more visible in the past few years (--books on tax tips and legal advice can now be bought in supermarkets), and publishers such as "Self-Council Press" have flourished. 9 As an early example of computer learning applications in this area, NABU Network plans to introduce instructional software delivered through their cable network to homes at low monthly costs.

Low cost and convenient delivery could make such applications attractive to consumers; it is also possible that eventually advertisers could subsidize "how-to" materials, if an application related to their product. Applications could also combine instruction with computerization of the task to be done; i.e., instructions on how to fill in your income tax forms, or how to keep account books, could be combined with applications programs themselves. (The children's software package, Bank Street Writer, for example, is a word processor with an educational component that teaches how to type). Such developments, however, are still speculative; the most evident application for practical instruction is how to use computers, discussed separately below.

A second aspect of at-home learning for adults is general interest learning. As earlier chapters discussed, many individuals take non-degree courses as "continuing education" out of interest, as a form of leisure activity. The social context of the classroom may be important in such cases; still, there may be a potential market for computers in the home to address. Also, many individuals are seeking informal training on their own initiative to improve job opportunities. The attitude toward non-degree courses is close to a consumer approach to learning: individuals choose and acquire learning as wanted or needed.

In many cases of informal training, people are interested in acquiring computer-related skills.

3. Instruction in the Use of Microcomputers

A proliferation of short courses about microcomputers is being offered by computer stores, software companies or computing services firms, as well as educational institutions. People want to learn what to buy, how to use the basic system, and how to use specific software packages.

Computer learning is an ideal vehicle to deliver such instruction interspersed with hands-on examples. Recently, a number of packaged software products for instruction about microcomputers have appeared. (For example, Dialogue Systems Inc., of New York, offers interactive training diskettes for Apple, IBM and other computers. The software packages teach BASIC programming, how to use several popular word processors and spreadsheets, and so on).

4. Merging Markets

Applications such as instruction in the use of microcomputers can be expected to be of interest to teachers, to adults who want to improve job skills, to large corporations for training employees, to small businesses, to home users--in other words, to any of the market segments discussed in this report.

Earlier chapters on post-secondary education and on training both noted the demand for informal learning. Individuals are seeking training on their own initiative; and more people are turning to educational institutions on an informal non-credit basis. In the next years, home microcomputers using retailed software may be positioned to meet such demands. As microcomputers at home begin to be used for informal learning, the education, training and consumer markets settings distinguished here will merge.

Meanwhile, at the school level, the education system will find that computer learning tools are multiplying both within its walls and in the consumer marketplace outside of them, as children use software on micrcocmputers at home. This will have an impact on the education system itself; its position as the major source of learning for children may change. At the same time, there will be a debate about the educational value of much of the material marketed as "educational games".

Outside of the formal educational world, what do we classify as learning? New kinds of learning games and toys will appear for children, and informal learning using computers will increase among adults. It is likely that our concept of "education" will change.

5. Summary

The consumer marketplace for computer learning is differentiated here as learning outside of either educational institutions, organizations which train employees, or government training programs. CL is carried out on microcomputers (or, in the future, with handheld units) using packaged software, acquired on a retail basis.

Three types of CL applications can be anticipated:

1. "educational games" for children, which have already exhibited rapid growth;
2. informal learning for adults, including practical instruction, general interest education, and informal training to improve work skills;
3. instruction in the use of microcomputers, a special case of adult learning where demand has already been shown.

Particularly in the areas of informal learning for adults, a merging of the three markets distinguished here (education, training, and the comsumer marketplace) will take place.

FOOTNOTES   CHAPTER SIX

1. Business Week, Mar. 19, 1984, p. 60.

2. Small business machines may be accessible for home use to a considerable extent: some small businesses are located in residences, and business people can take small computers home from the office. (There is also a tax incentive to claim that a microcomputer is bought for business rather than personal use).

3. Business Week, Jan. 24 1983, p. 81. InfoCorp estimate.

4. Business Week June 13 1983. Future Computing Inc. estimates.

5. The phrase is Business Week's, Jan 14, 1983, p. 81.

6. Ibid.

7. Ibid. Estimate is by Electronic Arts, a California startup company.

8. Ibid. Norman Ricken, president of Toys 'R' Us.

9. Self Council Press is a Vancouver-based firm whose sales doubled to $1.5M from 1978 to 1981. Globe and Mail, March 15 1982.

PART III

POLICY

PART III POLICY

As Chapter One described, a policy interest in computer learning arises for two main reasons from the industrial viewpoint. First, given the extensive role of the public sector in education and training, procurement decisions are already having major impacts on industrial development. Secondly, computer learning is an opportune and important "high technology" area. After a long phase of development, computer learning has become commercially attractive in three broad markets (as Part II discussed). Canada and other countries have emphasized "high tech" in industrial development, both to seek opportunities and to avoid trade deficits in fast-growing areas. Rather than become a passive market for foreign hardware and U.S.-made content, Canadian industry should pursue opportunities both domestically and worldwide.

An additional facet of policy interest in computer learning in the education system is the issue of Canadian content. For cultural reasons, Canadian textbooks have been preferred to less expensive imported material. Educational policies that favour Canadian content will benefit industry.

The policy context for computer learning is described in Chapter Seven. A number of government parties are involved: either through procurement or an interest in industrial development, at both federal and provincial levels.

This report focuses on the need to combine procurement with industrial goals, and to coordinate between the disparate parties whose decisions are influencing computer learning development.

Chapter Eight discusses strategies and mechanisms to promote computer learning. The importance of applications software and of the international marketplace are emphasized. This section also refers back to limiting factors in CL development (discussed in Chapter Two) that policies should particularly address.

Chapter Nine offers a set of recommendations as to how industry can be encouraged, both through government-supported education and training and by accompanying means.

CHAPTER SEVEN THE POLICY CONTEXT FOR COMPUTER LEARNING

This chapter describes the ways in which government actions have impacts on computer learning presently. Numerous parties are involved: from the user or procurement perspective, from an interest in industrial development, and from both federal and provincial levels of government. The policy context for CL is complex, and splits in federal/provincial jurisdiction make the areas of education and training sensitive.

The chapter begins with brief descriptions of the activities and roles of the various policy players whose decisions affect computer learning. A concluding section discusses the outcome of these activities and makes recommendations about changes in the policy context.

From the procurement perspective, in the education system provincial ministries of education have taken a number of actions towards microcomputers in schools. Two areas of federal involvement in education are also examined: the federal interest in post-secondary education, and the Secretary of State's program to fund learning materials in schools. A second major area of procurement interest is federally-supported training, and the Canada Employment and Immigration Commission and the military are focussed upon.

From the industrial development perspective, several provincial ministries have been involved in computer learning, as well as the federal

Department of Regional and Industrial Expansion and (to a lesser extent) the Department of Communications.

Lastly, a number of government councils which fund research are discussed. Two federal councils could potentially support computer learning projects at post-secondary institutions. Also, the National Research Council has been active for many years in computer learning, and developed the NATAL authoring language.

1. The Education System

i. Provincial Ministries of Education: Policies for Microcomputers in Schools

The various provincial ministries responsible for education have become the most active policy-makers for computer learning recently.(1) Their actions, however, concern elementary/secondary schools almost entirely; at post-secondary levels computer learning has received relatively little attention. As Chapter Four discussed, the use of microcomputers in schools has burgeoned, and ministries of education have been required to respond.

To administrators, the sudden popularity of microcomputers in schools appeared to bring chaos. As the chairman of the Ontario Teachers' Federation, put it, by mid-1979:

> ...we were having a revolution by infiltration with no control or compatability, no control over software, no provisions for networking, no long-term capital cost planning, no long-term curriculum development planning, and no long term teacher education and teacher re-education planning. It was simply helter-skelter infiltration, but it was indeed a revolution. And it seemed sheer common sense to have an evolution by strategic plan, by critical path approach, rather than the anarchy of infiltration.(2)

The provinces responded to this runaway phenomenum with various strategies. Though purchase decisions are made locally by school boards, nonetheless provincial policies can be extremely influential. Most of the ministries' actions have been responses to a set of problems described in Chapter Two concerning the supply of microcomputer content, and have often been reactions to teacher pressure. In general, outside of Ontario and Quebec, most provinces have tried to organize what content is available (as opposed to supporting new material), and the most common projects have been indexes and clearinghouses. A number of provinces have also made arrangements to use software from the Minnesota Educational Computing Consortium, or have promoted a particular make of hardware to reduce incompatibilities. Teacher training in the use of microcomputers is further major activity.

(a) Ontario

hardware

Until Quebec introduced its own plan, Ontario was the only province to choose to develop a Canadian-made microcomputer for school use. Several years ago, the Ministry of Education reacted to the liklihood that "offshore" hardware and software would dominate in schools, and began talks with the Ministry of Industry and Trade to consider Canadian industrial capabilities. In 1981 the Canadian Advanced Technology Association was asked to develop functional specifications for a Canadian Educational Microcomputer: a CEM. The CEM would be Canadian-made and would also be designed for educational use.

Ontario's support of a CEM has included funding at the design, development and prototype stages (of what is now the Icon computer), plus a policy to subsidize the purchase of CEM's by schools. An average of 75% of the cost of an approved microcomputer will be supported by the Ministry of Education. (A sliding scale allows up to a 95% subsidy to schools in poorer areas). So far, only Cemcorp's Icon computer has met the Ministry's specifications. Cemcorp is a private Toronto-based company formed several years ago to respond to the Ministry's plans. Other companies, including IBM, have shown interest in meeting Ontario's specifications but have not done so to date.

One of the stated motives in fostering a CEM was to avoid a de facto standardization in schools on the technically-limited 8-bit computer. (The Icon is a 16-bit machine with upwards compatibility). Other major technical features include: a local network design (connecting student units to a central file server); a user interface that emphasizes graphic images ("icons") and voice synthesis; and use of the Telidon presentation standard (now known as NAPLPS--see Chapter Three). The CEM specifications will be pertinent for a few years only; by that time, microcomputers generally will offer similar capacities. Within this period, however, the specifications favour the Icon.

Cemcorp's Icon is now being manufactured by Microtel Ltd. and will be placed in schools this fall. School boards have responded positively: the Ministry initially placed an $8M order for resale to schools, and a further $13M worth of orders have been placed by school boards themselves (in summer 1984). The relatively high cost of the Icon ($3000 for a minimally equipped unit) is absorbed by the Ministry of Education's subsidy; on average, schools pay only a quarter of the price.

Ontario's hardware project appears successful. In the past few years, the CEM plan weathered considerable criticism about the wisdom of supporting a Canadian microcomputer in a glutted hardware market. (Also, it is likely that

Ontario schools have held back from buying microcomputers while they waited for the Icon; the informal estimate for the province is 12,000 units, a much slower growth rate in the past two years than elsewhere). Now, however, purchases have been made by schools boards in other provinces, and Manitoba is considering arrangements for using the Icon. There has also been international interest, and a contract has been signed with Burroughs Corporation for Burroughs to service and market the Icon worldwide.

software creation

Ontario has also emphasized content development, taking the attitude that "the quality of educational software must dramatically increase."(3) In 1982, a request for proposals was issued for a project to create "exemplary software". 60 projects were selected out of a total of 600 proposals. This software was written before the Icon was developed, and is being used on existing 8-bit systems and converted for the Icon.

A second call for proposals followed. Ontario will spend $5M in 1984, rising to $10M by 1986. Proposals have come from publishers, software firms, institutions, and (in many cases) small teams combining teachers and programmers. The software project intends to fund the private sector; if participants are based in institutions, they carry out their activity on a private basis. The Ministry has emphasized quality and evaluation of content, including formative evaluation that reflects actual use by students.

The software applications will be licensed for use within Ontario schools, but the developer maintains rights to market the material outside of the province, or within Ontario apart from school use. The Ministry is also interested in assisting a company that would secure rights from developers (many of whom may be small partnerships) and market the material internationally. Within Ontario, licensed software will be distributed by the OECA (Ontario Educational Communications Authority) through an Ontario Educational Software Service. Eventually, satellite may be used to distribute software.

Other Projects

OECA has also undertaken a teacher training project for basic information about microcomputers, (the Teachers' Academy), using tv broadcasts accompanied by text material. Thousands of teachers have used this program, and a French version has been used in Quebec. Other projects include: the development of a version of NATAL for the Icon, and a computer learning centre at the Ontario Institute for Studies in Education, that will showcase equipment and software and house special resources for software authors.

(b) Quebec

Quebec was a pioneer in the use of computer networks in the education system for administrative purposes, but computer learning did not get an early start. Also, Quebec resisted some early discussions about cross-Canada networks for educational content, for fear of loss of identity to the English-speaking provinces.

As microcomputers appeared, they were slow to be used in Quebec. The availability of French-language content is a particular problem; also, machines did not offer French keyboards. In 1982, the estimate of the number of microcomputers in schools was remarkably low: only 400 units. There are probably ten times that number in 1984.

In 1983, the Ministere de l'Education produced a five year plan for microcomputers, with this comment on the need for action:

...nous n'avons guere le choix. Nous devons agir, dans ce dossier, des ette annee, sous peince d'un retard serieux. Certains, plus alarmistes, nous en font meme deja le reproches.(5)

The plan gives most attention to the school level, and addresses a number of facets of the use of computers: curriculum; teacher training (which receives particular emphasis); software and hardware; networked communications; and r&d and innovation.

hardware

Like Ontario, Quebec has linked educational procurement with industrial development. In 1983, when it published its plan of action, the Ministere de l'Education also published specifications for hardware, devised after consultations with educators. The Ministere de l'Education, the Ministere de l'Industrie, du Commerce et du Tourisme, and the Secretariat a la Science et a la Technologie were to be jointly involved in a call for proposals and evaluation of a suitable machine. Meetings with a number of firms were organized. (6)

The long-term plan is to place 45,700 units at all levels of education by 1988, (including 16,000 in primary schools). At an average cost of $4000, the total expenditure is estimated as $156M.(7) $42M was allocated by the Ministere de l'Education in a special budget "envelope" for purchases in 1984-1985. Schools boards make their own purchases, but will receive extra money if they buy the Ministry's approved machine.

The microcomputer selected is the MAX-20E, a version of an IBM-compatible microcomputer made by Mantra, a government-owned firm in France. A Montreal company, Bytec Comterm, will be the manufacturer. 9000 units are to be produced initially.

A considerable amount of controversy accompanied the government's choice. Another Mantra machine was selected initially, a decision resisted by the Quebec Federation of School Boards. (8) School boards asked for equivalent grants to choose their own equipment. Also, the machine did not meet the government's own specifications, and furthermore Premier Levesque had announced the choice only days after requests for proposals had been sent to a number of Montreal companies.

The MAX-20E is the result of redesign work. There are technical problems, and volume production is not expected until 1985. In the interim, schools will be able to buy other machines (that meet certain specifications, such as IBM compatibility) and collect subsidies up to the cost of the MAX 20E.

The success of Quebec's plan appears uncertain. Even if technical problems are overcome, the experience illustrates a risk of combining procurement with industrial goals: the choice made by government may not be what educators want. Quebec has also investigated Ontario's Icon, but no formal interest has been expressed.

Software

A particular concern is the lack of programs that reflect the linguistic and cultural context of Quebec. The plan of action budgeted some $6.7M (9) for software, and suggested two particular ideas: centres of excellence where educators and technical specialists from both the public and private sector could work together; and demonstration centres. However, it was not considered possible to specify needs in actual software applications when the plan of action was published; later, committees were charged with developing specifications that could be passed on to private industry.(10) Rather than purchase applications itself (as Ontario has done), the Ministry prefers that educational organizations carry out this role.(11) Another initiative is to modify the telecommunications network now in place in schools and colleges for administrative purposes so that microcomputers can be used.

(c) Alberta

In 1982, the Alberta Ministry of Education began a three-year Computer Technology Project that included: a clearinghouse; an Education in-service project for teachers; and a Minister's Task Force on educational computing.

A clearinghouse has been established for Apple material. Alberta also has a provincial licensing arrangement with MECC, and ACCESS (Alberta's educational communications authority) has a dubbing centre that makes copies of MECC material. Other software is evaluated and if an application receives a recommended status, copies are bulk-purchased and made available through the Ministry's School Book Branch.

Apple systems have been emphasized; several years ago, the Ministry bought 1000 Bell and Howell microcomputers which it resold to schools to encourage standardization on the Apple format. (Some industrial implications were considered--for example, whether local hardware manufacturing could be fostered; but the small market in Alberta discouraged this approach).

The Task Force on educational computing reported in 1983 with a number of recommendations, including the following: by 1985 all students in Alberta schools should have regular access to a computer; standards should be established for hardware and reviewed annually, and buy-agreements made with manufacturers; a computer network should be encouraged; and model "high tech" schools should be set up. Funding recommendations included the establishment of an Alberta Heritage Foundation for Educational Computing.

The Task Force also made recommendations concerning industry, including shared research, funding assistance, tax incentives, and assistance for national and international software marketing. A stated goal was that Alberta have "a viable courseware/software industry productiing material for use in the province and elsewhere."(12) Also, Alberta should encourage the federal government to introduce tax incentives.

However, little follow-up to these recommendations is taking place. The major action in Alberta has been the purchase of microcomputers by high schools for use in business education courses. It is estimated that these purchases may have doubled the number of units in schools, to as much as 12,000 to 15,000 machines.

Other initiatives in Alberta include a computer literacy program introducing students to microcomputers both at elementary and secondary levels. Also, at post-secondary levels and in training, considerable attention is being paid to laser videodiscs. ACCESS, Alberta's educational communications authority, and several universities have experimented with interactive videodiscs, for teacher training and nursing, for example. An Alberta Laser Disc Committee has been set up, and laserdiscs are beginning to be used in schools.

Several years ago, Alberta also initiated an indexing and cataloguing project for software, and was joined by several other provinces.(13) Eventually, this project shifted to the Council of Ministers of Education, Canada, discussed below.

(d) B.C.

B.C.'s most prominent activity in computer learning was a pilot project in 1980 that placed 100 Apple microcomputers in schools. Some seed money was made available for local development of content, but primarily MECC material was used. The pilot project report concluded that "the single most critical issue in the use of microcomputers in the schools of B.C. was the acquisition, development and sharing of quality material relevant to the B.C. Curriculum."(14) After this project, however, plans within the Ministry of Education for a more extensive role in CL were curtailed by general budget cutbacks. B.C.'s main action in computer learning at present is to operate a Provincial Educational Media Centre that has a license for MECC.

(e) Manitoba

In 1984, Manitoba's Ministry of Industry, Trade and Technology began an educational technology program, Infotech, to address needs for educational technology and foster economic opportunities, particularly in the area of applications software. Infotech plans to stimulate industry through: (1) technology transfer; (2) software content development support; and (3) technology pilots. Plans are at an early stage, but one aspect of the technology transfer strategy is to establish an educational technology resource centre with participation by industry. This centre could provide a display area for equipment, set up model classrooms, and offer software pre-view services. It could also aid content producers by offering access to special authoring tools.

In the past, Manitoba's main action in computer learning was a membership in MECC to support Apple content. (Only a small percentage of microcomputers in the schools were Apple's, however). The Ministry of Education also maintained a centralized computer service for both administrative and instructional uses. In addition, Manitoba has had an active educational consortium (The Manitoba Computer-Assisted Learning Consortium), which made a large number of programs available through the Ministry's mainframe computer, and also converted material for microcomputer use. This Consortium began in 1973 under the coordination of the Department of Education, the Department of Computing Services, the University of Manitoba, and various schools divisions.

Manitoba's recent decision to combine educational and industrial goals is occurring with federal support. As a later section describes, there is a set of special federal/provincial arrangements called ERDA's (Economic and Regional Development Agreements) that can fund provincial initiatives. Manitoba's plans for computer learning come under a sub-agreement in the area of culture and communication.

Infotech's emphasis is on software as opposed to hardware, and the province is not considering subsidies for hardware purchases. However, discussions with Ontario's Ministry of Education have taken place and it is possible that arrangements may allow software to be developed in Manitoba using the Icon. There are also plans for a network to connect microcomputers to central computers, for access to databases and software and also for administration and electronic mail.

(f) Saskatchewan

In 1981, the Ministry of Education in Saskatchewan drew up plans for action for microcomputer development that included software support and pilot projects. Expenditures, however, were not approved, and the subject was not considered a priority area.

For several years, Saskcomp (the provincial crown corporation for the supply of computer products and services) played a role in computer learning by selling Bell and Howell microcomputers. Saskcomp no longer sells hardware but continues to provide a membership in MECC for software. Recently, the Ministry of Education produced a "Directions" plan for computer literacy ranging from informal access in the primary grades to courses in computer sciences and applications in high school.

Saskatchewan has roughly equal numbers of Apple and Comodore microcomputers. The number of machines is expected to jump this school year, when 3000 to 4000 units may be in place.

(g) The Atlantic Provinces

Along with the other six provinces, the four Atlantic provinces have participated in the cataloguing project for software organized by the Council of Ministers of Education, Canada. Individually, New Brunswick has been most active and has set up a microcomputer resource centre designed to help teachers. The centre has a variety of systems and a software "depot". New Brunswick has catalogued an extensive amount of software and addresses both French and English-language needs. Nova Scotia is planning a resource centre as well.

New Brunswick has not made arrangements with MECC as there are few Apple systems in the province; however, MECC has made material for other systems (including IBM) available, and the Ministry of Education is now planning a membership. Also, some decision on standardized hardware will be taken by the end of 1984, and IBM is one system under consideration. There are over 1300 microcomputers in the province in the English school system alone.

In P.E.I., in March 1984 the Ministry of Education adopted a policy toward computer learning that included: a reaffirmation of existing computer literacy programs in schools, increased support for evaluation of software, and teacher inservicing. Also, the Ministry has supplied computers to schools for specific purposes (such as the use of a database called CHOICES for career guidance). Similar actions have been taken in New Brunswick and Nova Scotia. There were approximately 150 microcomputers in P.E. I. (in 1984).

Commodore machines have dominated in the Atlantic provinces, as in the past microcomputers were primarily used not for learning applications but to teach programming in high schools. Another trend in these small provinces is the presence of an internal curriculum consultant within the Ministry of Education, who advises on software.

Several years ago, two regional councils took an interest in educational computing;(15) however, no formal regional body is examining this area presently.

(h) <u>The Council of Ministers of Education, Canada</u>

A number of educational issues cross provincial boundaries, including computer learning. The sole formal body for cooperation is the Council of Ministers of Education, Canada. The CMEC was established in 1967, "to provide a means for the fullest possible cooperation among provincial governments in areas of mutual interest and concern in education..."(16)

The Council's history, however, has not been a dramatic one, and it seems to have preferred to skirt issues such as satellite communications and computer learning rather than embracing a role in their development. There is little sense that the CMEC is able to deal with areas of rapid development, or act as a problem-solver in contentious areas. A particular constraint may be a need to achieve a full consensus among members. The agreement of all provinces may not always be possible, and partial cooperation should also be an option. If, for example, only five provinces wanted to participate in a project, the CMEC could nonetheless be useful in getting the project underway.

The main involvement of the CMEC in computer learning has been a clearinghouse project to index content. This began as a cooperative project among four provinces; subsequently the CMEC became involved, and a full concensus on an indexing format has been achieved. The joint project is a milestone for the CMEC; however, the process has been slow and final approval will not be given before next year. Discussions are under way as to where a central database could be set up.

ii. <u>The Federal Interest in Post-Secondary Education</u>

Since Confederation in 1867, the provinces have had virtually full control over education policy, programs and institutions. In 1867, however, the public responsiblity in education consisted only of elementary schooling. Higher education, to the extent it existed, was usually supported by religious organizations. Since that time, as post-secondary education grew, the federal government became involved in a number of ways. A continuing role in industrial training began as early as 1910. Also, as higher education expanded rapidly in mid-century, a federal funding program began.

Today the federal government supports over half the cost of post-secondary education in Canada. This occurs mainly through transfers of funds to the provinces through the Established Program Financing (EPF) arrangements, which are unconditional block transfers that amounted to over $3B in 1981. (Appendix II describes the federal role in post- secondary education at more length). There has been some controversy over the lack of accountablity for these funds: the sums have grown but in some cases a province's support for post-secondary education has not. The federal/provincial split in education is a politically charged area. In 1984, for example, then-Prime Minister Trudeau commented that "I, and I think many others, would have liked to have seen a constitution that at least would have permitted the federal government to exercise its jurisdiction on post-secondary education."(17)

Given this sensitivity, any attempts by the federal government to increase its role in education will be viewed defensively by the provinces. (This presents a problem for computer learning, if, for example, a federal department wanted to fund experimental use of CL at a university). At the same time, teachers have called for more federal action in the educational area. In August 1984, the Canadian Teachers' Federation published a statement that "teachers favor federal financial support for the production of learning materials in Canada."(18) A report on higher education for the Association of Universities and Colleges of Canada lamented the lack of national policies, and stated that "higher education is becoming the last in a long line of federal-provincial conflicts."(19) Similar jurisdictional problems occur with training, discussed below.

iii. <u>Secretary of State: Computer Learning Materials</u>

The Secretary of State is a federal department which has had

EXHIBIT 7-1

FEDERAL EXPENDITURES AND TRANSFERS RELATED TO POST-SECONDARY EDUCATION

	1979-80 (actual)	1980-81 (budgeted)
University education:		
Operating grants:		
Military colleges	35.1	38.4
Other ministries: operating grants	16.3	17.8
Grants for sponsored research:		
Department of National Defense to military colleges	.7	.8
National Health and Welfare	9.2	1.3
Environment	.8	.8
Natural Sciences and Engineering Research Council	104.0	137.1
Social Sciences and Humanities Research Council	14.6	17.4
Medical Research Council	58.7	72.4
Research grants from other ministries	46.6	42.5
Capital grants	.9	1.0
Scholarship, student aid*	56.1	74.7
Cost of loans to students	47.1	63.0
Other ministerial expenditures	38.3	30.8
Total	428.9	498.0
Transfers to provinces for:		
Post-secondary education (EPF)**	2,775.5	3,074.8
Minority language programs	189.7	205.1
Total transfers	2,965.2	3,279.9

*Scholarships, bursaries, awards, student aid from many federal ministries and agencies.

**See Appendix II.

Source: Parliamentary Task Force on Federal-Provincial Fiscal Arrangements (1981).

responsibilities in cultural areas. These responsibilities have overlapped with the Department of Communications, and in fact programs for arts and culture have switched back and forth between these two departments. (The Department of Communications is discussed below).

Secretary of State has a "Canadian Studies Program" that funds the creation of Canadian learning materials,(20) and recently a new category was created for computer-based material. The main goal is to encourage learning material in a number of content areas considered to be neglected, including: Canadian social and political studies, Canadian cultural studies, and science curriculum in a Canadian context. The Canadian Studies Program is a rare example of direct federal support in an educational area.

2. Federal Training

i. Canada Employment and Immigration Commission (CEIC)

Chapter Five discussed CEIC's activities in industrial and manpower training. Its programs work in two main ways: first, the CEIC allocates money to industry itself, to encourage training to be done within firms. Secondly, the Canada Manpower Training Program (CMPT) buys "seats" for unemployed individuals in training classes. Chapter Five also discussed the split in federal-provincial responsiblities for training. The Manpower Training Program, for example, supports a great deal of training at post-secondary institutions, but this is done through provincial intermediaries. There is no way for CEIC to directly influence curriculum. The Skills Growth Fund, (whereby the CEIC can give capital assistance to institutions), has been the first mechanism for the federal government to directly fund computer-based training curriculum development and equipment purchases.

A number of projects using CBT have been supported in the past two years through the Skills Growth Fund, and indirectly CEIC has undoubtedly funded other CBT applications as well. However, because of jurisdictional limits, there is no way for CEIC to evaluate the effectiveness of CBT, or to investigate whether computer-based training saves public money by reducing training time.

Training has become a major federal policy issue recently. As part of broad changes in the economy, and particularly as a result of technological change, demands for labour are changing. Workers displaced by new technologies must be retrained, while in other occupations there are skills shortages. On a national level, the amount of training that will be needed in the coming years is striking. It has been estimated that by 1990 the average professional will need some type of retraining every four to five years.(21) In Canada, it has been predicted that 8M jobs may be affected by technological change in the next two decades, and that up to 40% of the work force will need retraining or upgrading in the next few years.(22) The pressure on the federal government to undertake training can be expected to intensify, but any investigation of computer-based training as a tool to meet these demands is hampered presently.

ii. The Military and the Public Service

Chapter Five also discussed the government's considerable training responsibilities within the public service and in the armed forces. There is a potential for government, and particularly the military, to act as a major client for computer-based training, and in the U.S. several military agencies have played a prominent role. The U.S. military has been the major "catalyst user" of CBT to date.

In Canada, where the military is a much more modest institution, nonetheless it undertook over $600M of training in 1981. Some experimentation with NATAL has taken place, and there has been some use of microcomputers and multimedia systems; but the major commercial CBT contract to date was given to a U.S. firm.

In the public service, computer-based training could particularly be evaluated as a tool for language education. Neither the military nor the public service has explored or supported computer-based training to any signficant degree.

3. <u>The Industrial Development Perspective</u>

In addition to government interest in computer learning through procurement, computer learning can be viewed as an opportunity area that can benefit from development strategies. Efforts to aid Canadian industry will reduce imported purchases and can encourage Canadian firms to engage in international trade, especially with countries other than the U.S. The importance of international markets is discussed in Chapter Eight.

i. <u>Provincial Ministries Responsible for Industrial Development</u>

Ontario's Ministry of Industry and Trade has been the most prominent provincial ministry involved in CL development, and has worked in conjunction with the Ministry of Education for several years. Ontario has also established an agency called BILD (the Board of Industrial Leadership and Development), a Cabinet committee centred around the Ministries of Economics and of Industry and Trade. BILD's agenda included a technology program to promote r&d, nurture high-tech companies, and expand markets. BILD has given considerable support to computer learning through the Ministry of Education's hardware and software projects. It has also funded an interactive videodisc project for training applications, carried out at the OISE (Ontario Institute for Studies in Education).

In Quebec, the Ministry of Industry, Commerce and Tourism has been central in the plans to produce a Quebec-made microcomputer for schools, and in Manitoba the Department of Industry has been active in the Infotech project and the Economic and Regional Development Agreement (ERDA) with the federal government that will fund computer learning software development.

ii. Department of Regional and Industrial Expansion (DRIE)

To date, the federal department responsible for industrial development has paid little attention to computer learning as a special area of high technology. Several reasons may have contributed to this situation, including the lack of good market projections for CL. Also, the funds for federal programs are often earmarked for established firms, and often large manufacturing firms (with numerous jobs) capture attention more easily. CL has not had priority in the federal Department of Regional and Industrial Expansion (or its predecessor department, Industry, Trade and Commerce).

DRIE funds a number of programs to aid industry, and it would be possible for a computer learning firm to be funded within the parameters of several programs. DRIE's primary program is IRDP (Industrial Regional Development Program), which provides grants and loans to firms. Also, the DIPP progam (Defense Industry Productivity Program) could fund applications for military use. However, computer learning has yet to stake out a place in industrial strategy.

Recently, DRIE has become involved in computer learning from another perspective. The now-defunct federal Ministry of State for Economic and Regional Development (MSERD) organized a number of General Development Agreements with provincial governments to pursue joint industrial ventures. Through this mechanism, substantial funds were transferred to less affluent provinces. This program has now reappeared as a set of new agreements to allocate federal funds to provinces: ERDA's (Economic Regional Development Agreements). Sub-agreements are set up in specific areas; Manitoba now has an arrangement in the area of culture and communications, and (as discussed earlier) is supporting computer learning from the viewpoint of industrial development.

A further federal program that could potentially fund computer learning firms is PEMD (Program for Export Market Development), run by External Affairs to aid Canadian companies in export marketing.

iii. The Department of Communications (DOC)

The Department of Communications has been connected with computer learning in several ways. The first concerns Telidon. As Chapter Three discussed, DOC has been closely involved in the development of Telidon (invented within its own labs) and the promotion of Telidon-based videotex and teletext. CL has been one applications area for these technologies, and several educational projects have been supported.(23) Secondly, DOC played a role in the federal ERDA with Manitoba, noted above.

Several years ago, the Department had a more direct involvement in CL. DOC had an Educational Technology Branch that engaged in an extensive policy examination of the use of computers in education. In 1975, this branch published a report by a "Federal Working Committee on Computer Communications in Education," which included computer learning as a topic. This report recommended support for r&d, subsidies for national projects, standards for technical compatibility, programs of support for CL in cooperation with provincial authorities, and funding of development projects to foster a competitive industry—all recommendations still relevant today. It also proposed that a government department or agency be assigned a leading role for coordination of federal support for r&d; one can suspect this would have been the DOC itself.

Also in 1975, this Branch produced reports on videodiscs and education and developed "ed-tech" projects in universities in several provinces. It appears that cooperation with the provinces was achieved. It also appears that lack of funds and/or federal-provincial politics intervened, as the Branch was dissolved shortly after the publication of its reports.

Many of today's centres of computer learning in Canada also existed in 1975, and one can only speculate how CL might have advanced with substantial funding for r&d and for special projects during the late seventies, before commercial interest picked up. These were years when computer learning relied on government support.

4. Federal Councils

A final link between the federal government and computer learning is through the government programs that fund research. Several councils support projects at post-secondary institutes. Such projects are a bridge between the education system and industry when they result in advances used in commercial products. Most of the major CL systems (described in Chapter Two) began in academic settings and moved into industry.

i. NSERC and SSHRC

Two main councils fund research in post-secondary education. The Social Sciences and Humanities Research Council (SSHRC) could potentially fund research on educational topics, including computer learning.(24) However, proposals for computer learning projects have generally been unsuitable because the technical component seemed too prominent. At the same time, however, research proposals sent to NSERC (National Science and Engineering Council) have encountered the mirror problem: computer learning projects include a non-technical, educational side that make them inappropriate for an NSERC grant.

NSERC's program is more closely related to industrial development. Its strategic grants support university projects that encourage "the transfer to the user sector of the technology and manpower generated through the program." It has been proposed that a stratetic grants program be set up specifically for computer learning, given that it fits so poorly into existing categories.

The U.S. provides an example of the successful use of a federal granting agency to support computer learning. As noted earlier, the National Science Foundation provided critical funding for the PLATO, TICCIT and LOGO systems, established a clearinghouse (25) and educational networks, and funded interactive videodisc projects.

ii. The National Research Council and ACIT

For nearly a decade, the NRC has been the main centre of activity in the federal government for computer learning. Its major project has been the development of the NATAL authoring language. Over $12M has been spent on NATAL, including $1.5M to $2M to transfer technology from NRC's government labs to industry through the PILP program (Program for Industry/Laboratory Projects). Through PILP, Honeywell Ltd. acquired the rights to market a NATAL implementation on its Level 6 minicomputer; however, Honeywell has made no commercial release of NATAL to date.

Since 1969, the NRC has been advised on computer learning by an Associate Committee on Instructional Technology. The purposes of this committee are: to formulate requirements for r&d, to promote interchange of information, to "promote and coordinate research, development and applications with the aim of establishing a strong Canadian-based capability," to encourage standardization of technology and to "foster the interchange of material."(26)

In the past, this Associate Committee organized several Symposia on Instructional Technology and produced papers on various topics, while more forceful roles in the development of computer learning failed to develop. More recently, this Commitee produced a paper titled "Towards a National Policy for a Computer-Assisted Learning Industry" (May 1984) that made a number of recommendations for government:

1) to recognize the computer learning industry as critical to Canada's economic growth;
2) to agree to the establishment of a national policy for this industry, "identifying goals, objectives and priorities which affect the economic independence and cultural identity of Canada";
3) to reaffirm the need for Canadian-made materials that reflect the Canadian context; and

4) to assign responsibility for this policy to make full use of "Canadian capabilities in federal, provincial, academic and industrial sectors".(27)

ACIT recommended that government act to expand the computer learning industry,(28) and also recommended that the National Research Council take the initiative for coordinated planning.

ACIT also suggested a number of actions that would generally benefit the computer learning industry, such as:

-committment of the federal government to the use of computer learning for its training needs;

-a program to support basic and applied research;

-a program to support national and international marketing;

-identification of a centre of responsibility or focal point within the federal government; and

-development of a Canadian content policy.

However, ACIT's recommendations also refer to an attached report which recommends a Canadian Courseware Registry. The functions of this registry include a "conversion service", whereby the registry maintains content in standard formats. It is argued that, while NATAL's opportunities in the marketplace are limited at present, NATAL should be adopted as the basis for the Canadian Courseware Registry Standard.(30) Thus the National Research Council's interest in computer learning continues to be tightly linked to NATAL.

5. Outcome and Recommendations

The first conclusion in this context is that various bodies of government are pursuing many uncoordinated policies toward computer learning. This report is based on three general recommendations:

1) public sector procurement of computer learning in education and training should be combined with industrial goals where possible. This approach encourages Canadian content, reduces balance of payment problems, and supports Canadian industry in an opportunity area with prospects for international export.

2) beyond the impacts of procurement, additional industrial development tactics are called for, some of which require federal actions;

3) the federal/provincial split jurisdiction in education and training has negative impacts for computer learning, and ways should be found for the federal government to pursue an interest in computer learning without overstepping provincial roles.

More specifically, four needs stand out in the present policy context from the industrial viewpoint:

i. increased coordination among provinces concerning microcomputers in schools, and increased awareness among provinces of the costs of fragmented development;

ii. increased profile at post-secondary levels, including research grants;

iii. evaluation of computer-based training by the major federal departments engaged in training, possibly followed by "catalyst" use of CBT;

iv. increased and federal attention to computer learning, from two perspectives: an interest in educational technology and an interest in CL as an opportune industry.

i. Microcomputers in Schools

At present, a number of different, and technically incompatible, approaches to computer learning are being pursued across Canada. This has resulted in a fragmentation that is unfortunate from the viewpoint of a supplier of computer learning content, and any attempts to coordinate among the provinces would be welcomed by software manufacturers. Often policies have been ad hoc responses, and if better channels for communication had been in place more cooperation might have been possible.

However, the situation that has resulted in computer learning reflects certain Canadian realities. Ten provinces are going separate ways; Quebec is pursuing a course all its own; and among English-speaking provinces, Ontario is dominant, while the other provinces have played relatively weak roles. In particular, in Ontario a major software creation program has emphasized quality. Because of incompatibility, this content (made for the CEM--Canadian Educational Microcomputer) will not be available on other machines in use. The other English-speaking provinces will continue to rely on U.S.-made material, imported either as commercial packages or through provincial ministries' arrangements with MECC. Industry, meanwhile, has been stimulated in Ontario in both hardware and software production.

Two years ago, Ontario was the sole province to attempt to combine educational procurement with industrial goals. Quebec followed this direction with its hardware project; Manitoba's Infotech is an industrially-oriented project; and an Alberta Task Force included industrial considerations in its recommendations (--which, however, have not been acted upon as yet). There has been an increased sensitivity to the fact that procurement should take place with consideration for industry; however, Canada is too small a market for three or four industrial strategies for microcomputers in schools to be pursued effectively.

At this point, Ontario's initiative offers the major opportunity for CL suppliers in the English speaking market. Markets in other provinces are too small and fragmented; Ontario, (given its size, the will which it has pursued its policies, and the fact that it has produced a satisfactory machine), can carry the market along.

Quebec's initiative is much more uncertain. The smaller market size and the fact that Mantra is making a similar machine in France limit the potential for hardware sales. Also, the specifications for the MAX 20 are IBM-compatible; schools boards could choose other machines with similar characteristics. Furthermore, the authoring of content is still a question mark.

Other provinces would do well to weigh the cost of remaining apart from Ontario's approach. One possible scenario is that Ontario's software projects will produce a pool of highly regarded material that is not available to students in other provinces. The Icon itself may be well-regarded. Other provinces may come under criticism for a reliance on U.S.-made material while students in Ontario use Canadian software. Also, industrial benefits are less likely to spread outside of Ontario without action by provincial governments. Any party across Canada can participate in Ontario's software projects; however, unless a province plays a facilitory role, new entrants in other provinces are unlikely. Estabished parties (such as software houses, publishers and long-time CL experts) may purchase Icons and make the necessary contacts with Ontario; but for smaller entrepreneurs, the liklihood of participation is much lower.

From the industrial viewpoint, the opportunity to participate in Ontario's software projects should be facilitated by provincial governments.

Provincial governments should also re-assess the costs to their own school systems of a lack of cooperation with Ontario, as Ontario's projects evolve.

Also, mechanisms for cooperation remain an important need. The slow pace and formal nature of the Council of Ministers of Education mean that this forum for exchange will probably be bypassed in favour of bilateral contacts among the provinces. The need exists for more opportunities for communication and informal exchange.

It is also recommended that the provinces move from positions that largely organize existing software to a more active support of computer learning. A number of mechanisms to promote CL are discussed in Chapter Eight.

ii. Post-Secondary Education

The lack of activity in computer learning at the post-secondary level is unfortunate from the industrial viewpoint, not only because it represents a relatively stagnant market but also because it fails to build up expertise. Research projects in computer learning now fall between the categories of the two major federal councils that fund research at post-secondary institutions. Also, because education is a provincial activity any federal funding of CL projects raises jurisdictional issues. The federal role in education remains unsettled, and educators have asked for expanded activities.

Computer learning projects at post-secondary institutions should be supported by both the existing NSERC and SSHRC funding programs, or by a strategic grants program specifically for CL.

Exemplary projects and production resource centres are other means to stimulate projects at the post-secondary levels, as recommended in Chapter Eight. Such initiatives could be funded either either by provincial ministries or by a federal focal point of interest in educational technology (recommended below).

iii. Federally Supported Training

The federal government supports enormous amounts of training, both internally (in the armed forces and the public service) and through the Canada Employment and Immigration Commission (CEIC). CEIC, the military, and the federal public service could all potentially be catalyst users of computer-based training. To date, however, neither the military or the public service has effectively supported CBT capabilities in Canada.

At the least, an effective evaluation of computer-based training should be carried out. Secondly, when CBT is implemented, public sector procurement should give preference to Canadian firms.
CEIC, however, is unable to evaluate or systematically support CBT because of federal/provincial considerations. While provincial ministries responsible for training can themselves do a great deal to support computer based training, CEIC offers the possibility of large-scale planned support.

The Canadian CL industry could benefit considerably if CEIC could:
(1) fund projects that explore the use of CBT, and evaluate this method of training for possible advantages in meeting federal training needs;
(2) coordinate systematically among the various projects it now funds that use CBT; and
(3) support the use of computer-based training, if CBT shows advantages.

If no such action is taken, then CEIC will continue to support computer-based training through such programs as its Skills Growth Fund and, (indirectly), through provincial institutions and through organizations who are training their own employees. There will be little coordination between projects; imcompatible approaches will be taken; and sharing or resale of material will be limited.

It should also be remembered that soon packaged training software for microcomputers will be more common. With CEIC support for CBT projects using microcomputers (either for classroom use or within firms), Canadian industry can begin activity in this area before an influx of U.S.-made material is available.

iv. Increased Profile at the Federal Level

Provincial ministries can do a great deal to support computer learning, as the example of Ontario has shown. However, there are several arguments in favour of increased federal involvement.

The federal government is now funding computer learning through at least six separate bodies: CEIC has funded several projects; the military has used CBT; DOC has supported a small number of projects; DRIE has received requests for grants from firms, and has been involved in a special federal arrangement with Manitoba; Secretary of State is funding computer learning materials; and the NRC has supported the development of NATAL and is now proposing an expanded policy role. There are no easy ways for the "right hand" to know what the "left hand" is doing, and it is difficult for any party to assess the industrial effects of its actions or understand clearly what industrial capabilities exist. Secondly, incompatible approaches may be pursued when coordination would be preferable.

There is a also a need for an advocate within the federal government that has an overview of the CL industry and that can make recommendations in other federal areas, such as copyright law, telecommunications regulation, and tax law.

Given existing federal/provincial sensitivity in education and training, any suggestion of an increased federal role in computer learning is not easily made. However, there is some procedence for expanded federal activity in commputer learning, with the former Education Technology branch at the Department of Communications. Furthermore, the U.S. provides an example of a federal role in education that has benefitted computer learning.

In the U.S., states have responsibility for education but nonetheless there has been considerable federal involvement in educational subjects. The federal government funds educational technology projects, examines policy issues, sponsers conferences, and so on. The Office of Technology Assessment of the U.S. Congress has examined computers in education; the Department of Education has funded educational television; there have been several commissions on Instructional Technology; and the National Science Foundation has had a long-standing and influential interest in computers and education. NSF has funded major CL projects and has also been interested in computer literacy.

> It is recommended that there be an organized focus on computer learning within the federal government, from two perspectives: from the industrial viewpoint, and from an interest in educational technology. This second entity could fund research projects (similar to what the National Research Foundation has done in the U.S.) and other initiatives recommended in Chapter Nine. It could also study some of the larger policy issues related to computers in education. Finally, it could fund the creation of learning materials, as Secretary of State has already done.
>
> Given current reorganization within the government, it is impossible to specify where these two focal points of interest in computer learning would be situated. One scenario is that DRIE might have the industrial responsibility while the area of educational technology was handled by the Secretary of State. (Alternatively, the Department of Communications could be involved, either in the industrial development or the educational technology area). Joint planning should occur between these two complementary perspectives on computer learning--as has occured at the provincial level, between ministries responsible for education and for industry.

In sum, there are three main approaches that can be taken towards computer learning. One is to maintain the status quo. The costs of this course of action include: fragmentation of the marketplace; incompatibilities that preclude sharing and reuse of software within the public sector; reliance on U.S-made material, both in training and in the school system where Canadian content is preferred for cultural reasons; balance of payment problems as Canada imports hardware and software; and lost opportunity for Canadian firms.

Secondly, measures can be taken to combine pubic sector procurement with industrial goals. This is considered here to be a minimal required course of action. Thirdly, further measures can be taken to encourage computer learning from the viewpoint of an opportune high technology industry-- the approach recommended by this study.

It is also possible that a national strategy for computer learning could be formulated, (as the Associate Committee on Instructional Technology has proposed). In the long term, given the increasing importance of computers in society, such a national strategy may be called for. However, in the near-term, it is unlikely that the concensus needed for such an approach can be found. Also, major issues in federal/provincial jurisdiction would have to be confronted. Other risks include over-centralized policy and distance from the user market, which may choose to behave in ways contrary to the preferred strategy.

This report recommends immediate action in the area of computer learning, and requires minimal adjustments to the federal-provincial context. Chapter Nine recommends specific policy actions to promote CL.

CHAPTER SEVEN FOOTNOTES

1. These Ministries are listed in Appendix I. Plowright, T., (1982) describes the actions taken toward computers up to 1982 in more detail.

2. ECCO, Proceedings of the ECCO Working Conference, Dec. 1980. (Des Dixon, chairman of the Ontario Teachers' Federation).

3. The Open Icon, May 1984, p. 3.

4. Quebec also resisted early efforts of Control Data to establish PLATO in Quebec schools and colleges.

5. Gouvernement du Quebec, Minstere de l'Education, "Micro-informatique: Proposition de developpment (4 juillet 1983).

6. Dubuc, Louise, in National Research Council (1983), p. 461.

7. Ministere de l'Education (1983), p. 36.

8. Globe and Mail, May 18 1984.

9. Dubuc, Louise, in National Research Council (1983), p. 461. This was the budget expected for 1984-85. Teacher training was expected to receive $800,000, hardware, $45M, research and experimentation, $1.9M, and a telecommunications network, $350,000.

10. Dubuc, Louise, "Le Plan du Ministere de l'Education du Quebec, Proceedings of the Fourth Canadian Symposium on Instructional Technology, held in Winnipeg, Canada, October 19-21 1983 (Ottawa: National Research Council, 1983).

11. For example, the G.R.E.C.S. (Gestion du reseau informatique des commissions scolaires) is suggested. Ministere de l'Education (1983) p. 29.

12. Alberta Printout, Dec. 1983.

13. Work on this project was done by a B.C.-based firm, JEM Research, now the Software Research Corporation.

14. B.C. Ministry of Education, (1981), report 03/81.

15. The Council of Maritime Ministers of Education and the Council of Maritime Premiers had groups or subcommittees with an interest in educational computing.

16. Council of Ministers of Education, Canada, Liaison, July 1981 (quoting from the "Agreed Memorandum" adopted in 1967 to establish the Council).

17. Globe and Mail, March 5 1984.

18. Globe and Mail, August 1984.

19. Globe and Mail, March 10 1984.

20. See Secretary of State, Ottawa, Canadian Studies Program, Information Brochure and Application Form. Funds are provides on a matching dollar basis, and some $4M is budgeted for the total program.

21. Datamation, April 1983.

22. Globe and Mail, March 5 1984.

23. For example, the Telidon and Education project carried out with OECA.

24. The Science Council of Canada is another federal council, whose role is to examine policy issues. Science Council has been interested in computer learning as part of a scrutiny of "The Information Society", and as part of an interest in science and education.

25. CONDUIT (described in Chapter Three) had NSF support.

26. National Research Council (1982).

27. National Research Council, Associate Committee on Instructional Technology (1984).

28. National Research Council, Associate Committee on Instructional Technology (1984), Appendix I, "A Strategy for the CAI Industry: Canada's High Tech Opportunity", report commissioned by the Subcommittee on Industrial

Applications of Computer-Assisted Learning (prepared by A. Benjamin and E. Brochu), April 30 1984.

CHAPTER EIGHT STRATEGIES AND MECHANISMS

This chapter discusses the means by which computer learning can be promoted. Two major factors are considered especially important: the need to emphasize software and to promote export marketing. Any planning (federal or provincial) should incorporate these two strategies.

Secondly, this chapter refers back to certain central problems in computer learning discussed in Part I: the cost of content development; problems in the supply of microcomputer content (including poor quality); and incompatibilities. Many of the policy moves taken towards computer learning respond to these problems.

The third part of this chapter discusses a number of policy mechanisms that can be used to promote computer learning. This report emphasizes the need to encourage CL not only by solving problems in the marketplace or through specific interventions, but through tax conditions, financing and export marketing assistance as well.

1. Areas of Emphasis: Software and International Markets

i. software

In almost all instances of "high tech" industrial stategies, hardware has received more attention than software. Industrial planners have felt that hardware production generated more employment than software; once software is written, reproduction requires little manpower. (With automated factories and robotics, however, hardware manufacturing will not necessarily create jobs). Only recently has software begun to receive encouragement in industrial development circles.

Content is the missing component in computer learning that is most often emphasized. Furthermore, the purchase of applications software is open-ended: more and more software can be bought and used. Already, software is influencing hardware purchases; the availability of content is often the deciding factor when microcomputers are bought.

Software is a growing industry: the Canadian domestic market grew from $457M to $600M from 1980 to 1981.(1) A growth rate of 28% is predicted, to reach sums of $5.4B by 1990. Applications software was the fastest growing market segment, increasing from $114M to $165M. Though this segment of the market was relatively small in 1981, it is expected to rise to $2.2B by 1990, at an annual growth rate of 34%.

Applications software should be emphasized in policies to promote CL. A recent report on the need for a Canadian courseware (i.e. applications) industry commented as follows:

> It represents the biggest opportunity for participation by the largest number of Canadians, it can reduce the amount of courseware that must be imported for use in Canada, it can be tailored to meet the requirements of education, home and industry, it is relatively undeveloped, and it is an area in which Canada can compete internationally.(2)

A number of software applications areas seem particularly promising for export. Most obviously, there is a demand for training in new computer skills: how to use microcomputers, how to use new office automation equipment, how to write software, and so on. It is practical for this training to be computer-based.

Also, in industrial training, software packages are appearing for "generic" types of skills. Canada can draw on expertise to create training applications in specific areas, such as the use of equipment in the resource industries. There is an immense need in less industrialized countries for training in the use of new equipment. Computer based training could accompany technology transfer; often technology is sold with insufficient training for use.

A number of provinces have taken measures to promote the software industry, and the federal government is examining this area as well. Internationally, several countries have forcefully promoted the software industry. Singapore, for example, a leading Newly Industrialized Country (NIC) in Southeast Asia, has successfully instigated a development strategy that gives predominance to knowledge-based industries, including computer and software production. This strategy utilizes: progessive industrial taxation; extensive export support; and manpower development to meet the needs of the new "brain industries" on which Singapore is basing her future. As part of the latter effort, several co-operative training institutes have been set up in Singapore, such as The Japan-Singapore Institute of Software Technology, and the French-Singapore Institute of Electrotechnology. These institutes, in addition to training Singaporeans in needed skills, serve as an integral part of trade promotion for France and Japan, as a way to penetrate the Southeast Asian markets. A similar Canada-Singapore institute is recommended in Chapter Nine for educational software.

ii. <u>Importance of Export Markets</u>

Diversified Trading Partners

The international context for trade is generally considered in three categories: the industrialized countries, the Newly Industrialized Countries (or NIC's), and the Third World. In Canada, trade with the U.S. has dominated overwhelmingly, and apart from the U.S. trade patterns have tended to lie with the industrialized nations. Increasingly, however, it has been realized that we are in the era of the global marketplace, particularly in the case of easily-transportable information products like computer software.

Many industrialized countries have focussed on "high tech" as a critical growth area, both to capture international opportunities and to avoid the balance of payment problems that result from being a passive market for imports. As a result, the competition in new computer-based industries is intense among industrialized nations. Several major projects have been set up to develop computer products, such as Japan's "fifth generation" computer project to develop artificial intelligence, and the ESPRIT project in the European Economic Community. Furthermore, many such countries have adopted a protective attitude as they seek to nurture domestic industry. While the GATT (General Agreemment on Tariffs and Trade) prohibits tariff barriers, numerous non-tariff barriers have been mobilized.

Such trends have several implications. Most obviously, they make competition difficult, especially in hardware manufacturing. Trade is also becoming more complex, as a firm may have to negotiate with government, and offer to set up local plants or make other friendly moves to sell in a particular country. In computer learning, education markets may particularly be subject to protective procurement policies. (Britain, for example, has used a subsidy similar to Ontario's to support its indigenous microcomputer, the Acorn).

Meanwhile, the economies of several newly industrialized countries are flourishing, and more interest is awakening in these countries as trade partners. There too, computer industries are being developed. Some countries are making efforts in hardware manufacturing, (including both authorized and unauthorized replication of U.S. models). Several NIC's are endeavouring to develop software industries, and have devised policy strategies accordingly. The case of Singapore was mentioned above.

Finally, the Third World comprises an enormous portion of the world with immense education needs. The Third World, however, has a history of failed high-technolgy projects, where foreign technocrats, perhaps in cooperation with an educated elite, sell computer equipment and other advanced technologies which remain unused, or out of service because there are no replacement parts available, or no one was able to maintain the equipment properly. Cultural sensitivity was often lacking; in poor countries, such expensive projects were particularly unapt. Third World countries now are more likely to weigh the appropriateness of imported technology, and to resist the one-way influx of cultural goods. Co-operative projects, adapting technology and applications to a particular environment, may be sought. Canada, to date, enjoys a relatively high reputation in the Third World because it has been less associated with such past projects than other countries, such as the U.S.

Third World markets for training are of special interest. The importation of technology without adequate training has been a particular problem in the past, and computer-based training could be used to accompany technology transfer to the Third World. Also, as industries develop in Third World countries, a great deal of training will be needed.

There may also be a demand for applications in higher education, which must now often be pursued by studies abroad. In the longer term general education needs, including basic literacy, may be met by computer tools such as handheld special-application devices, which in a few years will be technically powerful, cheap and compact.

In sum, the market for computer learning is global and trade, particularly with new partners, should be actively encouraged. However, international trade must be accompanied by sensitivity in dealing with Third World markets, both to avoid the technological failures of the past and to maintain goodwill as these markets develop over time.

Above all, a good trade environment is important. Canadian firms need to operate within a favourable context of trade agreements. They also need export market support that encourages expansion into the international marketplace--financing arrangments, market intelligence, cooperative ventures with foreigh countries, etc. A supportive framework for trade should be emphasized in policies for CL.

Export Market Capability

The nature of the products that Canada has exported in the past has not required extensive marketing efforts: 30% are primary commodities and raw material, and 40% are standard fabricated materials.(3) There has been little need to develop high-powered international marketing expertise, or for public sector marketing support to evolve. Also, the U.S. market has dominated our vision and the sense that international marketing is needed at all is relatively recent. Thus our export marketing capabilities are limited at present.

There are other constraints upon Canadian sallies into international markets. For example, there is a shortage in market intelligence available to Canadian firms. (This could include sales leads for products abroad, information on market conditions and practices, information on sales potential in foreign countries, contact lists for foreigh buyers, etc.) Secondly, the small size of many firms limits their participation in export marketing, except in joint ventures or consortia. These firms often lack the capacity to establish an export base, and are strained by the documentation and other complexities of international trade. Industrial development for computer learning should emphasize ways to encourage international exports.

2. Limiting Factors in CL Development

Chapters Two and Three gave a basic introduction to computer learning that included several factors that limit development. A number of central problems were discussed:

i. the high cost of content creation;
ii. problems in the supply of microcomputer content (poor quality, copyright infringements, and disorganized supply channels);
iii. incompatibilities;
iv. shortage of expertise.

Many of the policy moves discussed in the next pages address these areas, especially the problems in the supply of microcomputer content that have been acutely felt by schools. A number of activities have organized the supply of software, such as cataloguing or licensing arrangements. Copyright infringements, meanwhile, are being addressed by a number of measures, including technical solutions that prohibit copying, group leasing arrangements, and copyright law (as Chapter Two discussed). Incompatibilities are being addressed by three main approaches: standardization; conversions; and authoring techniques that minimize rewriting when material is transferred. Standardization policies should be careful to be flexible toward technical advances, especially the development of more intelligent CL.

In addition to dealing with problems in the supply of existing software, policies should aim to improve the quality of content (especially through artificial intelligence (AI) approaches), to decrease or offset the high costs of content creation, and to build up expertise (ranging from teacher training in how to use microcomputers to expert authoring).

Artifical intelligence is expected to have a transformative effect on the quality of computer learning, but (as Chapter Three discussed), the use of AI is limited by the lengthy time required to create applications. A number of mechanisms described in the next pages reduce the high cost of content creation that is a problem both with AI applications and conventional CL. The use of authoring tools can be encouraged; r&d for new authoring tools can be supported; and production centres can allow authors to use time-saving equipment. Another limiting factor with AI is accessibility, i.e., few CL specialists have the access to intelligent applications that is needed to gain experience and in turn create their own programs. Any ventures supported in computer learning that include AI approaches have the indirect benefit of increasing expertise.

Chapter Three also emphasized the diversity of hardware that computer learning can use, including videodiscs and telecommunications networks of various sorts. Computer learning is an area subject to rapid technological changes; any planning should be flexible towards technology.

3. Mechanisms for CL Development

The types of policy actions that can be taken towards computer learning are divided here into three broad categories. A policy-maker could variously decide to:

Organize the Marketplace:

i) build up knowledge about computer learning;

ii) organize content supply;

iii) standardize hardware.

These approaches work with what is available in the existing marketplace. Other actions support new industry ventures. A policy maker could:

Provide Financial Support:

iv) become a major client and "catalyst user";

v) fund exemplary projects (at user sites);

vi) fund r&d;

vii) subsidize CL suppliers or users;

viii) set up production centres (a form of subsidy for authors).

This set of measures consists of specific interventions. More generally, policies can:

Create Favourable Conditions for CL Suppliers:

ix) provide favourable tax laws, financing assistance, and export market support.

i. building up knowledge about CL

Teacher training in the use of microcomputers is a major concern in the education system. Special training programs have been set up in most provinces, but additional efforts in this area remain a priority. Another means to educate both teachers and other interested parties about CL is the use of resource centres. Such centres can include hardware demonstration areas, and facilities to pre-view software before purchasing.

It is recommended that teacher training be emphasized by provincial ministries, and that other mechanisms to increase knowledge about computer learning, such as resource centres, be utilized as well.

Outside of the education system, (in the training context, for example), mechanisms such as workshops and conferences could be useful in increasing awareness of computer learning.

ii. organization of content supply

The bulk of the actions taken by provincial governments (described in Chapter Seven) have organized content supply. These moves reflect the problems teachers faced as microcomputers multiplied. They deal, however, with the existing marketplace; that is, the ministries have organized the supply of U.S.-made content and hardware. While these actions are helpful to teachers, they have not been designed to help Canadian industry.

EXHIBIT 8-1

STRATEGIES IN CL DEVELOPMENT

I BUILD UP KNOWLEDGE

- .computer literacy
- .teacher training
- .resource centres
- .model schools

II ORGANIZE CONTENT SUPPLY

- .exemplified by the clearinghouse: solve information problems (document and evaluate content, collect available material, index and catalogue, etc.)
- .establish licensing arrangements, right-to-copy agreements, etc.
- .subscribe to sources of content such as MECC
- .disseminate software
- .establish networks for distribution

III ORGANIZE THE HARDWARE MARKET

- .amass larger markets through bulk purchasing or procurement policies that encourage schools to buy certain machines
- .set standards

IV ACT AS A CATALYST USER

- .purchase and use equipment
- .develop applications

V EXAMPLARY PROJECTS

- .demonstrate "proof of concept"
- .set up exemplary projects
- .use the Request for Proposal process as a means to stimulate interest in CL

VI R & D

- .fund R & D projects in industry
- .fund projects at post-secondary institutes

VII SUBSIDIZE

a) give money to produce hardware, software or content (through grants for R & D, exemplary projects, etc.)

b) give money to user markets:

- .grants or special terms for those acquiring hardware, software, or content or incurring telecommunications costs

VIII PRODUCTION RESOURCE CENTRES

- .provide facilities and tools as a form of subsidy to authors

IX CREATE SUPPORTIVE CONDITIONS OF BUSINESS

- .favourable tax conditions
- .financing aid
- .export market support
- .international trade agreements
- .beneficial treatment of software as a product
- .accomodating tel communications policies

The major ways to organize content include: indexing and cataloguing projects; standardized systems for evaluation; clearinghouses, which can both distribute information about what content is available, and also distribute software (if the software is "public domain" material, or if special arrangements for distribution have been made). Most provinces have engaged in some form of indexing, cataloguing, or evaluation, and the Council of Ministers of Education, Canada, has an indexing project that involves all ten provinces. Ontario has also set up a software distribution service, first using floppy discs and later to use an educational network that now links schools for administrative purposes. Eventually, satellite technology will be used.

Provincial ministries have also made licensing arrangements for the use of content within their schools. Most notably, many provinces have arranged to use MECC material. These moves increase the content available to teachers, and also alleviate copyright problems by reducing the tendency for schools to "pirate" software. Bulk-purchasing from commercial suppliers is another way to faciliate content supply for teachers.

Conversion facilities are a way to make content available on incompatible machines. Several provinces have supported conversion activities, which often include enhancement of the application being worked upon. It has also been proposed by the NRC Associate Committee on Instructional Technology that a national conversion facility be established as part of a national courseware registry (as Chapter Seven described). A major problem with this suggestion is the uncertainty of demand among users for such a facility. Secondly, the economics of such an operation are unclear. Also, the use of NATAL as a standard intermediate language for storing courseware entails certain risks associated <u>with</u> standardization. As Chapter Two discussed, the use of a standardized authoring language may limit advances. Ontario, for example, is encouraging the use of a number of authoring tools and is standardizing only at the level of programming languages. Standardized authoring languages may particularly limit the use of intelligent CL.

> Indexing, cataloguing, clearinghouses, evaluation systems and software distribution systems are valuable means to organize the marketplace for software, as are bulk-purchases and licensing arrangements. However, in the education system, provincial ministries have been organizing the marketplace for U.S. made material, and for material whose quality has not been adequate. Content creation should be emphasized.
>
> Secondly, where imported material is converted, enhancements to improve quality and reflect Canadian settings should occur.

iii. <u>standardized hardware</u>

Provincial ministries have also taken actions that have standardized hardware to reduce the use of incompatible systems. Formal specifications have been used, as well as bulk-purchasing. Also, arrangements to use a particular type of software have encouraged the use of a specific system in schools (Agreements with MECC, for example, have encouraged the use of Apple systems).

> Standardization serves a useful purpose but also has several associated risks. In the education system, if provincial ministries standardize formally on different systems incompatibilities will be entrenched. Standardization can also inhibit technical advances.
>
> Any standards set should be reviewed periodically, in light of both technical advances and Canadian industrial impacts. At present, policies should avoid excluding Ontario's microcomputer until its success can be better assessed.

iv. <u>The Catalyst User Model</u>

As earlier chapters have commented, the U.S. military provides the best example of "catalyst use" that has stimulated the development of technology and the computer learning industry itself.

In Canada, the Ontario Ministry of Education has filled the catalyst user role, both in hardware, with the Icon, and with its extensive software creation projects as well. Potentially, CEIC and the military stand out as large single users of CL, whose procurement decisions could greatly benefit Canadian industry. Catalyst use can consist of both hardware and applications software, and can benefit the whole spectrum of CL activities.

> Catalyst use is recommended here as a major method to promote computer learning. Such use is not a manufactured need, but rather is part of ongoing procurement for education and training.

v. Exemplary Projects

Exemplary Projects set up working models that people can use. Like catalyst use of computer learning , they can stimulate activity in hardware, software and applications areas simultaneously.

There are several international examples of the use of exemplary projects as a successful strategy to advance CL. In the U.S., the National Science Foundation provided critical "proof of concept" funding for the PLATO, TICCIT, and LOGO systems during their early years, and supported other projects such as clearinghouses, educational networks, and instructional videodiscs. Also, in Britain some years ago, the NDPCAL (National Development Program in Computer-Assisted Learning) stimulated the creation of computer learning projects that were in operation years after the NDPCAL ended. In Canada, the Ontario Ministry of Education funded an "exemplary lessonware" project for $2M in 1982.

The NSF's efforts have been aimed at:

..."proof of concept" experiments, demonstrations, and field tests designed to reduce the uncertainty for the commercial sector and to offer compelling educational evidence to the academic community.(4)

Like catalyst use, exemplary projects have a number of strong points as a means to promote computer learning. First, interest can be stimulated among a wide community by issuing a request for proposals to undertake the project. Secondly, because exemplary projects can include hardware, authoring software, and applications components, they involve different sectors of industry simultaneously. Third, the project builds up expertise. And fourth, an exemplary project has a visible and useable result, that can build awareness of computer learning and its potential.

Exemplary projects are a major recommended mechanism to promote computer learning. In particular, projects should be carried out in post-secondary education, where use of CL is slow.

vi. R&D

"R&d" has been almost a banner word in recent years in federal policy, as a means to achieve success in a high-technology world. There is no doubt that r&d is essential to CL development. Computer learning is at an early stage of evolution; as early chapters emphasized, its use so far has been primitive and the resources for the computer (for intelligent interaction, natural dialogue, etc.) have scarcely begun. R&d efforts must be made, in both short-term and long-term projects: in the short-term, to meet visible needs (such as authoring tools), and also with a long-term perspective for research in leading-edge areas.

Government support of r&d, however, is no simple panacea, and has a number of limitations. Above all, r&d is a risky business. In a case study of three large U.S. companies, only 12% of their projects generated an adequate profit.(5) Eventually, a product has to face the marketplace: "Most r&d projects fail because they do not sell---not because they do not work". Furthermore, r&d costs are only a fraction of the total investment a company makes in establishing a new product. Marketing in particular may be critically important, and also costly.

In this situation, problems arise when government tries to "pick a winner" by funding r&d in industry. To name a few difficulties: decision-making is likely to be slow; it is hard to both start and stop a project with government involvement; and those in government are often isolated from the marketplace. Also, the federal government may have secondary agendas to spread funds across the country which confuse the selection process. Finally, while the product of the r&d may be technically flawless, a firm may lack necessary marketing strength.

Ultimately industry itself must take responsibility for the commerical success of a product. Industry, meanwhile, has often found that the difficulties in cultivating government grants outweight the benefits. Many firms prefer to use tax write-offs for r&d instead. (A 150% write-off for r&d expenses above a threshold level plus a special tax credit are provided now). A variety of tax policies could be used to encourage industry to invest in r&d projects (e.g. accelerated write-offs and reductions in capital gains taxes.)(6)

Government is also involved in r&d through the support of research in its own labs or in universities and colleges. In these settings, long-term research can be carried out. All the major CL systems in use today were the result of long-term research efforts with public sector support; however, at present computer learning slips between the cracks of the two main federal councils that fund research at post-secondary institutions.

Much of the research and development needed in computer learning concerns the use of artificial intelligence. Authoring tools are a particular need at present. Advances in instructional design and cognitive psychology are needed as well.

It is an important characteristic of long-term research that while commercial benefits may eventually result, they cannot be predicted:

> Who could have predicted when the double-helix structure of genes was discovered in 1953, that this would lead to the birth of the biotechnology industry a generation later? Many of the fruits of basic science are unexpected windfalls.(7)

The Japanese have incorporated this attitude in their Fifth Generation Computer Project. This is a project with ambitious technical goals, and it is fully acknowledged that these goals may not be reached. En route, however, "windfalls" are expected as a result of the massive research effort that has been set in motion.

> It is recommended that r&d projects be supported at post-secondary institutes (by both provincial and federal governments). In industry, r&d should be promoted by grants to firms but more generally should be promoted through tax incentives. AI, including authoring tools to promote intelligent applications, is a particular area of interest.

vii) Subsidies to Users and Suppliers

Subsidies are possible in many forms. Funds can be given to the supplier firms that produce hardware, operational software, or applications-- through grants of the type that DRIE administers, for instance.

It is recommended that government consider grants for computer learning suppliers as a priority area in industrial development, especially when export market potential is demonstrated.

Subsidies can also be given to user markets, and this has been a major mechanism used with microcomputers in schools. Ontario has used a subsidy scheme to promote approved Canadian Educational Microcomputers (--to date, only the Icon). Schools receive an average of 75% of the cost of a CEM; with a sliding scale, schools in less wealthy districts can receive up to 95% of the CEM's cost. Britain has similarly encouraged the purchase of its approved indigenous computer, the Acorn. (As a result, 80% of all computer being sold to British schools are Acorns). Quebec is also subsidizing approved microcomputers through grants to schools. (However, in the months before Bytec Comterm produces the government's chosen machine, schools will receive subsidies for other machines).

It is recommended that other provinces consider subsidies for microcomputers in schools to foster equal access to computers in different school districts.

In the training context, subsidies could be given to firms to use computer-based training through the CEIC programs that now fund training within industry. CEIC could fund such projects initially to investigate the usefulness of computers in training, and later as a preferred means of training if advantages appear.

viii) Production Resource Centres

Production resource centres are a particular form of subsidy for authors of computer learning applications. Ontario, for example, will set up a centre that offers resources for teachers such as display areas for hardware; in addition, this centre will provide access to special authoring equipment and tools. Manitoba similarly plans to establish a centre with facilities for authoring.

Such centres can encourage content creation by reducing costs through faster authoring, by eliminating the need to buy certain equipment, and by improving the quality of applications (through special graphics systems, for instance). They can also offer access to a staff of experts, and provide a means for less experienced authors to apprentice and acquire skills.

> Production resource centres are recommended here as a means to offset the high costs of content creation.
>
> In particular, production centres outside Ontario should be equipped with Icon hardware and authoring software, to give authors across Canada the opportunity to participate in Ontario's software projects.

ix) Supportive Conditions for Business

Special interventions and public sector procurement affect only a relatively small number of firms. Computer learning firms generally can benefit from such conditions as: favourable tax laws, that particularly encourage the software industry, and favourable financing arrangements that alleviate cash-flow problems. Government can also provide useful information services, such as on-going lists of Canadian ventures in computer learning and up-to-date industrial capabilities.

Export market support is considered especially important. Industrial development ministries can help firms by providing international market intelligence, and programs such as DRIE's Program for Export Market Development can encourage entry into foreign markets. Tax laws can also encourage export activity. A particular recommendation made in Chapter Nine is that a joint institute with Singapore be established for educational software, to facilitate entry into Southeast Asian markets.

In addition, copyright laws can address the problem of copyright infringements and illegal "pirating". Finally, Chapter Three noted the importance of telecommunications policies that affect the industries that could deliver CL. Policies should encourage experimentation in new services, and provide assurance that market entry is possible, if investment in experimental phases is made.

> In addition to interventions that benefit specific firms, policies should build a favourable framework for CL suppliers generally. Tax law, financing assistance, copyright law and telecommunications policy should encourage computer learning market entry. Also, government can offer information services useful to suppliers or to clients for CL.
>
> Export marketing should be encouraged by tax laws, programs that fund export market development, and trade agreements and joint ventures that faciliate entry into foreign markets. Also, markets should be diversified from the dominant trading patterns of the past.

FOOTNOTES CHAPTER EIGHT

1. Wills, R.M., et al, (1984). Evans Research Corporation estimates.

2. NRC, Associate Committee on Instructional Technology (1984), Appendix II, report of the Subcommittee on the Development of a Courseware Industry, p. 12.

3. Ontario, Board of Industrial Leadership and Development (Jan. 1981), "Technology and Exports: Priorities for Ontario's Growth".

4. Molnar, Andrew (1975),

5. The Economist, June 26 1982, "The Pitfalls of Trying to Promote Innovation"). Most projects were stopped at early stages, but even among commercialized products only 40% were profitable.

6. Wills, R.M., et al, (1984).

7.The Economist, June 26 1982, p. 96.

CHAPTER NINE RECOMMENDATIONS

Chapter Seven described the policy context for computer learning and made several recommendations about the roles to be played by the diverse policy makers in this area. Three broad goals were emphasized:

1) public sector procurement of computer learning in education and training should be combined with industrial goals where possible. This approach encourages Canadian content, reduces balance of payment problems, and supports Canadian industry in an opportunity area with prospects for international export.

2) beyond the impacts of procurement, additional industrial development tactics are called for, some of which require federal actions;

3) the federal/provincial split jurisdiction in education and training has negative impacts for computer learning, and that ways should be found for the federal government to pursue an interest in computer learning without overstepping provincial roles.

More specifically, four needs stand out in the present policy context from the industrial viewpoint:

i. increased coordination among provinces concerning microcomputers in schools, and increased awareness among provinces of the costs of fragmented development;

ii. increased profile at post-secondary levels, including research grants;

iii. evaluation of computer-based training by the major federal departments engaged in training, possibly followed by "catalyst" use of CBT;

iv. increased and federal attention to computer learning, from two perspectives: an interest in educational technology and an interest in CL as an opportune industry.

Chapter Eight discussed a number of specific mechanisms to promote CL, and emphasized the importance of software applications and export marketing. This chapter offers a set of recommendations to support computer learning from the industrial viewpoint.

1. Federal Involvement in Computer Learning Policy

There are several arguments for an increased federal role in computer learning (as Chapter Seven discussed). First, the federal government is already funding computer learning through at least six different agencies. It is difficult for any one of these agencies to assess the industrial effects of its actions in this context, and incompatible approaches may be followed when coordination would be more effective. There is also a need for an advocate within the federal government that has an overview of the industry and can make recommendations in other federal areas, such as copyright law, telecommunications regulation and tax law.

An organized focus on computer learning should be established within the federal government, from two perspectives: from the industrial viewpoint, and from an interest in educational technology. This second body could fund research and exemplary projects (similar to what the National Science Foundation has done in the U.S.) It could also study some of the larger policy issues related to computers in education.

In the current configuration of government, the industrial interest would like with DRIE (Department of Regional and Industrial Expansion) or the Department of Communications (DOC), and the educational technology interest with Secretary of State, which is already funding computer learning materials. Joint planning should occur between these two complementary perspectives on computer learning--as has occured at the provincial level between ministries responsible for education and industry.

2. Provincial ministries of education should continue to support teacher training and organizational measures such as indexes, clearinghouses and software distribution services. However, provincial ministries should go beyond organizing the marketplace for foreign products or for software of poor quality, to support content creation through catalyst use of computer learning, exemplary projects, and production resource centres.

Also, provinces outside of Ontario should weigh the costs of not participating in Ontario's approaches to computer learning. If, for example, good quality Canadian content is made available for CEM's (Canadian Educational Microcomputers), other provinces may be critized for using U.S.-made material. Also, industrial opportunities may be lost, while Ontario benefits from the stimulation of content creation projects. While other provinces may not be prepared to adopt Ontario's system, they should facilitate local participation in Ontario's software projects. They should also avoid setting standards for systems incompatible with CEM specifications until Ontario's approaches can be better assessed.

All forms of coordination between the provinces should be encouraged, including informal channels of communication among decision-makers and educators, such as conferences and electronic networks. The formal body for interprovincial coordination, the Council of Ministers of Education, Canada, should also be encouraged to play a more energetic role.

3. "Catalyst use" of computer learning, by provincial ministries, CEIC (Canada Employment and Immigration Commission), the military or the public service could greatly promote the computer learning industry. Use of computer learning is recommended here not as a manufactured need but rather as part of the extensive procurement activities of government in education and training.

In particular, CEIC should be enabled to evaluate computer-based training systems, to coordinate among the different CBT projects it funds, and to support CBT if advantages are found. Federal/provincial split jurisdiction in training now limits CEIC's role.

4. Exemplary projects should be funded by provincial ministries, and by the federal department with an interest in educational technology. Federally-supported projects should proceed with provincial co-operation; however, without a federal funding mechanism, such projects seem much less likely to occur. They are most important in the post-secondary setting where there is little activity in CL, and where expertise must be built up (in instructional design, authoring, etc.) that can be drawn upon by a growing industry.

5. Production resource centres are a means to offset the costs of

content creation and subsidize authors. They can also establish expert teams and provide access for novices to experienced authors.

Provinces should in particular offer access to Icon machines for authoring, to facilitate local participation in Ontario's software projects. Production centres should be set up at teacher resource centres established by provincial ministries or at post-secondary institutes (funded by provincial ministries or by a federal interest in educational technology). CEIC could also establish production centres for authors making content for its training programs.

6. R&d at post-secondary institutes should be funded by provincial ministries, by NSERC and SSHRC, and by the federal government out of an interest in educational technology. Artifical intelligence, and authoring tools for making AI-based applications, should particularly be emphasized.

7. R&d should be supported by industrial development ministries in grants to firms, and more generally should be encouraged within industry by favourable tax laws (as discussed below).

8. Industrial development ministries should recognize computer learning as a "high-tech" opportunity area, and should give subsidies to firms who especially show export potential.

9. While industrial development grants to aid firms can be expected to quickly bring responses from industry, development efforts should concentrate on creating a favourable framework for CL suppliers generally. Policies should place less emphasis on awarding grants to specific firms than upon

establishing a larger supportive environment. Favourable financing and tax conditions and export marketing incentives should be established, especially for the software industry.

Federal tax policy is the responsibility of the Department of Finance; nonetheless, some party with a specific interest in computer learning will be needed to propose that favourable tax policies be set. Several countries have used a flexible tax system to support software and research and development in general. (For example, in Singapore, 200 percent of reinvestment of any firm's profits in research and development activities are tax-exempt, and in any new innovative process, tax exemptions are granted for prototype development and manufacturing start-up phases).

It is recommended that Canadian r&d incentives be made applicable to software development costs. The amount of exemptions should also be significantly increased, i.e., doubled, to be competitive with those of other nations.

10. A computer learning section within DRIE (or DOC) can also provide supportive information services that are useful to CL suppliers or clients--monitoring Canadian suppliers, for example, and collecting market information. The training market in particular requires study. Export market intelligence would be valuable as well.

11. Federal and provincial governments should fund training in the area of computer learning to address the problem of shortage of expertise. Courses could be funded at post-secondary institutes; graduate study programs in computer software could be maintained and enlarged; and special incentives

could be granted to domestic firms and multi-national subsidiaries in Canada which will engage in sophisticated training for software authoring.

12. The development of export markets should be emphasized, and in particular the Icon educational microcomputer should be used as a vehicle for sales of Canadian training/educational software throughout the newly industrialized countries of the Pacific Rim and elsewhere.

Canada is a small market and is highly permeable to imported products which must be offset by world-quality exports. A variety of mechanisms can be brought to bear to encourage expansion into export markets: favourable trade agreements, financing aid, market intelligence, information on how to do business internationally, representatives abroad to provide information and contacts, and so on.

Export potential should also be considered in awarding funding grants to firms. Also, greater attention should be paid to markets outside the traditional trading patterns of the past (i.e. the U.S.) Several countries have established export diversification incentives in the form of tax drawbacks for firms which export high-technology goods with a specified percentage of national content. Such a graded drawback scale should be established in Canada, giving priority to exports of software/services. Since an intention of such diversification incentives is to encourage Canada to trade with partners other than the U.S., incentives in the form of drawbacks or tax exemptions might be region-specific, i.e. they should be higher for Pacific Rim and South American countries.

Given the opportunities in Southeast Asian markets, it is particularly recommended that the feasibility, costs and benefits of establishing a Singapore Institute for Canadian educational technology be examined. Possible benefits of such an Institute to Canada involve: (a) greater export diversification; (b) an opening to a large emerging market in an area of the world where Canada enjoys a favourable ideological and political position; and (c) an improved understanding of and access to CL markets in Asian countries.

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APPENDIX I

MINISTRIES RESPONSIBLE FOR EDUCATION

British Columbia	Ministry of Universities, Science and Communications Ministry of Education
Alberta	Education Alberta Advanced Education and Manpower
Saskatchewan	Department of Education Department of Continuing Education
Manitoba	Department of Education
Ontario	Ministry of Education Ministry of Colleges and Universities
Quebec	Ministry of Education
New Brunswick	Department of Education and Continuing Education
Nova Scotia	Department of Education
Prince Edward Island	Department of Education
Newfoundland	Department of Education

APPENDIX II

FEDERAL SUPPORT FOR POST-SECONDARY EDUCATION*

At the time of the BNA Act in 1867, when education was designated a provincial responsibility, post-secondary education hardly existed. By the mid-twentieth century, it had become a substantial financial burden to the provinces.

A 1937 Commission (The Royal Commission on Dominion-Provincial Relations) suggested that despite constitutional restraints, the provinces might welcome federal grants to their universities, and a 1951 Commission (The Royal Commission on National Development in the Arts, Letters and Sciences) supported the idea of federal assistance to universities, in cooperation with provincial governments. The federal government began a program of direct assistance to universities in the year 1951-1952 (amounting to 50¢ per capita in each province).

By this time, the subsidies that universities had been receiving for veteran enrolments had declined, and the grants were welcomed by the universities themselves. However, the plan was less well-received by the provinces, as a recommended intergovernmental process had not been followed. Quebec in particular opposed the grants and directed its institutions to refuse them. A federal-provincial agreement in 1959 settled the issue.

The grants increased over the years until they were replaced in 1967 by the Federal-Provincial Fiscal Arrangements Act. At that time university enrolments were expected to double in the next ten years. The federal government proposed a special arrangement of fiscal transfers to the provinces, based on "foregone tax transfers" (i.e., the government reduces its taxes by a certain amount, enabling the provinces to raise their own taxes by corresponding amounts), plus additional payments. In 1977, the Established Program Financing arrangements (EPF) came into effect. Compensation is based on population plus certain economic indicators, and is made half in cash, and half through a combination of tax transfer and further cash payments. Support varies from province to

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*See Parliamentary Task Force on Federal-Provincial Fiscal Arrangements (1981), pp. 55 ff., for a brief history of the "Evolution of Federal Support of Education in Canada."

province. In Newfoundland, for example, the federal share of funding of post-secondary education operating costs was 84%, and in B.C. it was 54%, while the average for Canada was almost 61%.* (This includes a number of direct payments to institutions and individuals in support of activities.) (See Table .)

Other forms of federal support in post-secondary education include student loan programs, and research funds for universities awarded through several granting councils, such as the National Research Council, the National Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC).

Recently the EPF transfers have come under scrutiny. They are large unconditional transfers to the provinces, and neither the federal government nor Parliament receives an accounting for these transfers. Also, the transfers are made as block funds that also include support for provincial health programs, and no funds are actually earmarked for educational use. It seems that the value of the transfer for post-secondary education has grown faster than provincial support for higher education in recent years.

A 1981 Task Force (on Federal-Provincial Fiscal Arrangements) recommended that block-funding continue, but through a program that was separate from health-care support. It also proposed the establishment of a focal point for the internal coordination of federal programs related to post-secondary education (i.e., Secretary of State for EPF programs, Canada Employment and Immigration Commission for Training, plus the granting councils). A further recommendation urged greater accountability to Parliament, including an annual report which should discuss the results of federal consultations with the provincial ministers (i.e., the Council of Ministers of Education, Canada) on national purposes in education.

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*Ibid.

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